RATIONAL DIET

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AN ADVANCED TREATISE ON THE FOOD QUESTION

BY

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PREFACE

The aim of this book is to disseminate a better knowledge of diet in its relation to health and disease, in plain non-technical language, understandable to all who seek more scientific information on this vitally important subject. Health and success in the life of the individual, as well as of nations, depend primarily on living in harmony with nature's laws, on the intelligent conservation of our vital forces and on the development of our highest mental faculties.

There is no doubt that man could wonderfully increase his capacity for physical and intellectual work by paying proper attention to the principles of rational nutrition, thus insuring normal functioning of all the bodily organs. The proverb *mens sana in corpore sano*—"a sound mind in a sound body"—is true for all time.

The author's interest in the food question developed early in life, when he recognized the inadequacy of the prevailing methods of cultivating food products and of artificially preparing them for the table. For thirty years, both in Europe and America, he has been a close student of the laws of diet and health, and his writings are well known. The present volume is the result of many years of careful study of the subjects of food chemistry and nutrition. The author has stressed the value of organized mineral elements, or organic salts, which are the most essential factors in the normal growth of the body in maintaining vitality and increasing its

power of resistance. Indeed, the wonderful creative work of nature throughout the plant and animal world is largely due to the actions and reactions of the mineral elements and their vibratory forces, whose great importance in the processes of life and growth is just beginning to be recognized.

If human welfare is enhanced through a more general application of the principles outlined in this volume, the author will consider that his efforts have been well repaid.

The author wishes to express his gratitude to Conrad Seiler and Charles Whipple for contributing many valuable suggestions and criticisms in connection with the preparation of the present volume.

OTTO CARQUÉ

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PART II

Foods—Their Origin, Nutritive and Hygienic Value and Their Relation to Health and Disease

INTRODUCTION

Never in the history of civilization has mankind made such material progress as during the latter part of the nineteenth and the beginning of the twentieth centuries. This has been an age of great inventions. Steam and electricity have revolutionized completely the ways and means of transportation; the telephone, telegraph and radiograph have minimized the time of communication; the automobile has brought city and country more closely together, while the aeroplane has still further conquered time and space.

Enormous individual fortunes have been accumulated by those in a position to profit by the advantages that modern machinery and a rapid increase of land values afford. While the aggregate wealth of the leading nations has increased immensely, it appears to the close observer that our much-boasted progress has been one-sided in many respects, since poverty and crime, famine and disease still hold their unabated sway in human society.

The so-called infectious diseases, the terror of ancient, mediæval, and even semi-modern times, have more or less disappeared, because of improved sanitary conditions, better housing and drainage, in short, thorough cleanliness, strictly enforced in the large centers of population. The plagues and fearful epidemics of old do not terrorize us any longer, but these have been replaced by another evil, which, more subtle and cunning in its workings, is none the less pernicious in its results. It is the belief that disease is an entity, the result of outward influences, instead of the cumulative effect of our perverted dietetics and hygienic habits.

Those who have carefully studied the laws of health agree that the main source of disease is to be found in the declining quality of our food supply, the result of foolish attempts to improve on nature. Although food may be ample in quantity, modern machinery is constantly removing some of the important elements, and in many cases adulterants and poisonous preservatives are added to disguise the inferior quality. According to our present knowledge, there are about eighteen elements required to build the human body. These elements, which must be supplied in an organized form by our food, may be called "the building stones of the body."

And since they constitute the organic salts and are the constructive agents for the final erection of the ideal physical man, they cannot with impunity be dispensed with or inorganic material substituted in their stead, for lack, or deficiency, of any of these elements will in time cause serious disturbance, and ultimately wreck the human edifice. Nearly all diseases that have baffled the medical profession may be traced to some deficiency in our diet, and it may be truthfully said, that at least ninety per cent of human ailments are traceable to inadequate nutrition. Yet in no field of study and observation has medical need been more insufficiently met than in that of rational dietetics, both in relation to the maintenance of health, and to the treatment of disease. It is, in fact, amazing to the conscientious student to note the almost universal failure to fully recognize the importance of the organic salts in the compilation of books on physiological chemistry, and in the general attitude of so-called medical authorities toward this fundamental subject.

At one time *calories*, or heat units, were thought to be a sufficiently substantial foundation upon which to build a system of healthy nutrition, but this was abandoned as a delusive method for determining the nutritive food value of food. Substances that show a very high caloric value may often lead to starvation because of their deficiency in organic salts, and other elements of nutrition.

Neither can the recently discovered *vitamins*, important as they are, solve the problem of building a strong and healthy organism, since they supply neither energy nor tissue-building substances. Vitamins appear to be integral parts of all plant protoplasm, and to be primarily connected with the germination and development of seeds and the nourishment of the young plant. While vitamins are admittedly essential, they can be active factors in the health of the human and animal organism only when the organic salts are present.

It is highly important, therefore, to study the chemical composition of all foods regarding the amounts of the mineral elements they contain, in order to determine their true nutritive and hygienic value. Comparatively few analyses of this kind have been made in this country. As early as 1904 the author wrote to Dr. Harvey W. Wiley, then chief of the Bureau of Chemistry, a

branch of the U. S. Department of Agriculture, Washington, D. C., and this was his reply:

"I regret to say that no one in this country has undertaken a complete analysis of all the mineral constituents of foods. An analysis usually relates to the nutritive value and general composition, but does not give, as a rule, the composition of ash.

"I think it is highly desirable that the composition of ash be carefully studied and hope that some chemist will take that matter up in the near future.

"Respectfully,

(Signed) "H. W. Wiley."

In Europe the importance of this branch of dietetics was recognized at a much earlier date, and numerous analyses have been made determining the percentage of the various elements in foods, especially by the German chemists, Drs. Koenig and Wolff. While Baron Justus von Liebig was one of the first to establish a new system of agricultural chemistry, we owe a great deal to the far-seeing genius of Dr. Julius Hensel. He, by his tireless investigations and observations, clearly demonstrated the importance of the mineral elements for the healthy growth of the plant, as well as of the human and animal body. He was followed by Dr. H. Lahmann, of the world-renowned sanitarium, "Weisser Hirsch," near Dresden, Saxony. Lahmann published a number of books in which he showed that the deficiency of certain organic salts and the resulting retention of toxins in the body are the causes of the majority of functional diseases. In applying his discoveries in his sanitarium he met with remarkable success, and many representatives of Europe's nobility were among his patients. Lahmann's dietetic treatment of disease is now practiced in nearly all the leading Nature Cure sanitariums of Europe. A successor of Dr. Lahmann, Dr. Ragnar Berg, has published a valuable book, in which he gives complete analyses of a large number of foods. Dr. M. Hindhede, of Copenhagen, who made many interesting experiments in nutrition, may also be mentioned here.

Another German physician who paid special attention to the subject of mineral elements in foods was Dr. William Schuessler, of Oldenburg. His system of bio-chemistry, which he employed extensively in the treatment of disease, included the inorganic elements, that, possibly, have a temporary and stimulating effect, but produce no permanent cure. A similar system of healing by the application of cell salts has been propounded by Dr. George

W. Carey, of Los Angeles, who has published a number of interesting books on his theories. While the works of the early bio-chemists have revealed some important truths, the fact can never be too strongly emphasized that the highly developed human body, in order to maintain supreme health and efficiency, requires the elements of nutrition in an organized form, as found in the cells of natural foods.

Dr. A. Gautier of Paris, and Dr. Alexander Haig of London, have also made some valuable contributions to the new science of nutrition, and their works are well known to students of dietetics. Sampson Morgan of Tenterden, Kent (England), has made valuable studies in regard to the importance of mineral elements in the fertilization of the soil which he described in his books "Clean Culture," and "The New Soil Science."

Among the early pioneers in America, who stood firmly for natural methods of living and healing, must be mentioned Dr. Sylvester Graham, Dr. Russel T. Trall and Dr. A. F. Reinhold. They have laid the foundation for a better understanding of the relation of diet and disease and of natural methods in the restoration of health. Although their work found but little recognition during their lifetime, still they paved the way for a rapidly and constantly increasing number of nature cure physicians and dietitians. Among those who deserve much credit for their untiring efforts in educating the people to a better knowledge of the laws of life, may be mentioned: Drs. B. Lust, Elmer Lee and Eugene Christian of New York City; Dr. John H. Kellogg of Battle Creek, Michigan; Drs. H. Lindlahr, J. Drews and V. G. Rocine, of Chicago; Dr. R. L. Alsaker, of St. Louis; Dr. J. H. Tilden, of Denver; Dr. Harry Ellington Brook, editor of the "Care of Body," Los Angeles Times; Drs. George Starr White, Axel Emil Gibson, Philip Lovell and John T. Richter, all of Los Angeles, California. The late Professor Arnold Ehret, who conducted a large sanitarium in Switzerland, before he came to California, may also be included among these pioneers.

Special attention should be called to the extensive nutrition experiments of Professor Meyer E. Jaffa, of the University of California, to which more detailed reference is made in the pages of this book. As early as 1900 Professor Jaffa made a number of dietary studies with fruitarians as subjects.

Professor E. P. Forbes, and others of the Ohio Agricultural Experiment Station, have made very interesting investigations in regard to the mineral metabolism of farm animals, especially of the milch cow, which have been published in a number of bulletins. Bernarr McFadden, Milo Hastings and Alfred McCann, of New York City, are doing most valuable work in educating the country through their publications and books, and seem to enjoy an increasing appreciation. Professor E. V. McCollum of Johns Hopkins University, Baltimore, devoted considerable study and research to the vitamin theory. He published his results in his book, "The Newer Knowledge of Nutrition."

Notwithstanding the progress that has been made in the science of nutrition for the last thirty years, diet-reform is progressing slowly. We are living in an age of commercialism, and millions of dollars have been invested in the manufacture of demineralized food products, for which a large demand has been created by shrewd, misleading advertisements, often supported by statements of chemists, evidently hired for the occasion. The general public, devoid of exact knowledge concerning food values, buys these impoverished products, unaware of the fact that they gradually undermine health and vitality.

We are spending billions of dollars in guns, battleships and the maintenance of armies and navies while but an insignificant amount is given for improving the quality of our food, and, incidentally, of the soil from which it draws its sustenance. Careful analyses of all food products should be made frequently to determine the amounts of the different organic salts they contain, as this is the only sound basis upon which a system of rational nutrition can be established.

It is from these points of view that the author has given the subject of foods and nutrition most careful study for the past thirty years, and has published a number of small treatises, now out of print. These publications have been enlarged upon in the present volume, which especially treats the subject of organic salts in food, and their relation to health and disease—*the missing link in dietetics.*

The problem of nutrition, its relation to the growth and development of plant and animal organisms and to the action and reaction of the elements constituting the organic world, are better understood if we give a general survey of the electronic theories

of matter, atomic vibration and of the evolution of cell life. These theories, which have been fully accepted by the leading scientists, show what the material manifestations of life are thought to be, and how the wonderful psychic force of the creative processes is reaching down to the atomic groups of the different elements, drawing them to itself, and transmitting them into organic life in the form of the organized cell. Health means normal digestion, assimilation and elimination. All these depend upon normal atomic cell vibration, arising from a perfect equilibrium of the life elements.

Despite the unprecedented material progress of mankind during the past generation, there still remains one great obstacle to the general advancement of human welfare and happiness. It is the almost appalling ignorance of the average individual regarding the laws of his being. Unfortunately, much that is called education at present simply renders a man unfit to successfully fight the battle of life. The great need of our time is a saner and more wholesome standard of living, upon which a new and higher civilization must be built.

Having realized these important facts, the author has tried to outline a rational system of diet, giving a concise, yet comprehensive view of the chemistry of foods, their origin, cultivation, nutritive and hygienic value and showing at the same time the pitfalls into which the artificial and irrational preparation of our foodstuffs will ultimately lead. Faulty nutrition is one of the principal causes of degeneration, disease, suffering and premature death. The foundation of all lasting reform must therefore begin with the purification of the body which naturally leads to the improvement of the intellectual and moral faculties.

Those who have acquired a deeper understanding of the true relation of food to health will realize that diet reform, which, in a larger sense, means the mental and physical regeneration of the individual, must become one of the most essential of all reforms, and that only by making the unit, the individual, in society healthy and self-supporting shall we be able to solve successfully the social and economic problems that confront the world today. Dietetic and hygienic habits have always been a most important factor in the rise and downfall of nations. Likewise the source and purity of its food supply will remain one of the most vital factors in the progress and welfare of the human race.

PART I

CHEMISTRY OF FOODS WITH SPECIAL REFERENCE TO THE ORGANIC SALTS

RATIONAL DIET

CHAPTER I

Matter and Energy

It is difficult to delve deeply into the phenomena which continually present themselves in all animate and inanimate matter, without a clear comprehension of the great unchanging laws that govern the evolution of suns and planets, as well as the formation of the grains of sand washed by the ocean wave; of the laws that reveal themselves both in the growth of giant trees which have stood the storms for thousands of years, and in the fragrant flower which grows beneath their shade and dies at the end of a summer; of the laws that govern the birth and death of men who may walk the earth a century or more, as well as the microbe whose existence spans but a day or an hour.

In elucidating our present subject we have to consult primarily two branches of science—chemistry, dealing with the composition and transformation of matter, and physics, which investigates the transformation of energy and the laws which govern it.

Chemical analysis of all the various forms of matter, gases, liquids and solids, has led to the discovery of more than ninety distinct substances called elements, which cannot be separated by any ordinary means now at our disposal, into simpler substances. The science of chemistry is divided into two branches—inorganic chemistry, dealing with the chemical composition of inanimate matter; and organic chemistry, which is concerned with the more or less complex compounds found in, or derived from, plants and animals.

Energy manifests itself in different forms of which we may distinguish the following:

Energy of gravitation	Electrical energy
Energy of heat	Magnetic energy
Energy of elasticity	Radiant energy
Energy of cohesion	Vital energy
Chemical energy (affinity of the elements)	

These various forms of energy may not be distinct from one another, but simply represent so many different manifestations of higher or lower potentiality. Life is the most complex expression of the transformation of matter and energy.

The ninety elements are, figuratively speaking, the building material of our planet, solar system, and probably of the universe; but undoubtedly there are a number of elements in the universe that still await discovery. Most of the elements which make up the surface of our planet are easily obtained, while others exist in such small quantities, hidden among other substances, that they are extracted only with the greatest difficulty. Thus the newly discovered element of radium, even in its impure state, is a thousand times rarer than gold.

A number of the elements like gold and a few of the other heavier metals are generally found in the elementary state. Our atmosphere consists chiefly of the two elements, oxygen and nitrogen, in the free state. Carbon, copper, silver and sulphur are occasionally found in the elementary state, but most of the elements exist in chemical combinations. The number of elements composing the materials which chiefly make up the organic part of our planet, including the plants and animals is comparatively small. The solid surface of the earth is mainly composed of substances such as quartz or flint, chalk or limestone and various combinations like feldspar and clay. The elements which are the chief constituents of these substances are oxygen, hydrogen, nitrogen, sulphur, phosphorus, calcium, magnesium, aluminum, iron, manganese, potassium; silicon, chlorine and fluorine.

In order to explain the intricate changes of matter chemists have adopted the atomic or molecular theory, which was first promulgated about 480 B. C. by the Greek philosopher, Leucippus, and later elaborated upon by Democritus of Abdera (460-371 B. C.). About the year 1750 the Italian scientist, Boscovich, presented this theory to the world in so clear a manner that it has become the accepted idea. In the beginning of the nineteenth century Dalton brought it to its present perfection by showing that matter is composed of indivisible particles or atoms in varying numbers and weights. So infinitesimal are these molecules that a billion of them are only barely visible with the most powerful microscope,

and a speck of matter, in order to be visible to the naked eye, like a grain of dust, must be a million times larger.

The molecules of a given element always consist of a certain number of the same atoms, whereas those of compound or chemical combinations are aggregations of different atoms. Furthermore, the molecules which constitute a certain elementary substance, are alike in weight and general properties, but differ from the characteristics of the molecules making up some other elementary substance. For instance, the molecules of iron have different size, shape and weight than those of sulphur.

The study of the changes which take place in the composition of molecules under the influence of various forces, and which result from their action upon one another, is the work of the chemist, while it is the field of the physicist to study the influences of those forces which affect matter without in any way altering its atomic structure, for instance, in the mechanical division of matter.

To summarize the atomic theory of matter, as we know it today, we may give the following definitions:

A *molecule* is the smallest particle of a substance that exists in a free state, and which has the same composition as any larger mass of the same substance.

An *atom* is the smallest particle of an element that exists in any molecule.

A *compound* is a substance whose molecules contain two or more kinds of atoms.

An *element* is that part of a substance which contains only one or more of the same kinds of atoms. In mercury, for instance, one molecule consists of one atom only, and the two terms become congruent in this case. The molecule of hydrogen consists of two atoms, and that of phosphorus of four atoms.

Another interesting fact should be mentioned here. It was found that out of the list of the ninety or more elements little groups could be selected with similar properties corresponding under certain conditions to all the elements of other groups. In other words, the elements of one and the same group seemed to be related to each other. In the year 1863 the chemist, John Newland, pointed out that if the elements were arranged in tabular form in the order of their atomic weight they fell naturally into such groups; that elements similar in chemical affinity occurred in the same columns, and if, moreover, the number of the elements between

any one and the next similar one was seven, the members of the same groups would stand in the same relation to one another as the extremities of one or more octaves in music. This wonderful relationship between the elements was further investigated by the Russian chemist, Mendeleeff, and the German scientist, Lothar Meyer, and resulted in the discovery of the periodic law, or the periodic system of elements, which may ultimately lead us to a more perfect knowledge of the history of evolution and the rhythmic laws governing the development of both organic and inorganic matter. In his interesting and instructive book, "The New Knowledge," Professor Robert Kennedy Duncan says:

"This periodic law of the atoms is God's alphabet of the universe. By means of it, and by means of it only, can we ever hope to spell out the history and the future of creation. It lies here before us lacking only the master word, the open sesame, to creation, and, who knows, to the Creator, too?"

The relationship and periodicity of the properties, evident in the elements, has lead to the theory that the atoms of the elements are made up of still smaller particles, which act in the atom just as the atoms act in the molecule, and that atoms, as we know them, are the result of evolution from simpler forms. Further investigations revealed the fact that the slight conductivity of gases, may be vastly increased until they become good conductors; and this knowledge again led to the discovery of certain electrified particles in gaseous form, the so-called *ions,* consisting of the positive particles which are simply called "ions" and the negative particles or "corpuscles." While the size of an ion is about equal to that of an atom of ordinary matter, that of a corpuscle, is about a thousand times smaller than that of the hydrogen atom. The corpuscles travel through space with wonderful velocity, ranging from 10,000 to 100,000 miles a second, and from a comparison of the two kinds of ions, it appears that the negative corpuscles are far more important. They seem to be the carriers and workers and builders of the universe and all it contains. The corpuscles have led to the electronic theory of matter, and in that connection these particles are generally given another name. They are called *electrons.*

Prof. J. J. Thomson, of the Cavendish Laboratories, of Cambridge, England, has perfected the theory of the electrons, for which work he was awarded the 1906 Nobel prize of $40,000. He has reached the conclusion in his electronic theory of matter,

which is at present accepted by nearly all the leading scientists, that *the electron is the ultimate unit of all matter.* The atoms are made up of electrons or disembodied electrical charges in rapid motion; the atom of one elementary substance only is the number and arrangement of electrons contained in it. Thus it becomes clear, that the ultimate unit of which all matter is composed, is not matter at all, as we ordinarily understand the term, but electricity. *Matter, then, is a pure hypothesis, and energy is the only reality.* The electron, being a disembodied charge, contains no matter, and is the electrical unit.

The electronic theory teaches that the atoms of all matter are composed of numerous electrons that are at all times in a constant state of motion or vibration; that the electron is the electrical unit, and that the negative electrons are greatly in excess of the positive; but that the positive electron controls the vibration of the negative ones and holds them within the atom; that *vibration is the primal law of nature and is universal in its application, leaving nothing exempt from this law;* that the atoms of matter themselves are made of negative charges of electrons, each aggregation of electrons being surrounded by a sphere of positive electricity; that consequently, *matter, in its last analysis, is identical with electricity.*

The atomic masses of the chemical elements differ as widely as 1.01 for Hydrogen and 258 for Radium, and all intermediate orders of magnitude are met with. These masses are due to the electrical charges or number of electrons of which the atoms of all the elements are composed. The heavier atoms contain a larger number of electrons than the lighter ones—the approximate number in any atom being expressed by the atomic weight of that atom in terms of Hydrogen as a unity, multiplied by 770, this being the number of electrons in a Hydrogen atom.

In the appendix of this volume will be found a copy of Mendeleeff's Periodic Table modified, showing the atomic weight and number of electrons in over seventy of the best known elements. Mendeleeff has also originated the conception that ether instead of being some mysterious form of non-matter as generally believed, is actually the lightest and simplest of the elements, and a definite form of matter. The atomic weight of ether he concludes to be nearly one-millionth of that of hydrogen, and its atoms consequently travel with enormous velocity. This extreme velocity he

explains by the all-pervading character of the substance. An atom of ether must be infinitesimally smaller than the electron.

The size of an electron must be at least one hundred-thousandth of the linear dimensions of an atom; a size with which its penetrating power and other behavior is quite consistent. Assuming this estimate to be true, it is readily seen how very small these electrical particles are, compared to the atom of matter. If an electron is represented by a sphere an inch in diameter, the diameter of an atom of matter on the same scale is a mile and a half. In other words, each atom represents a miniature solar system in itself, with the electrons moving with very high velocity. Indeed, the different characteristics of chemical elements may be explained by the relative number of positive and negative electrons their atoms contain. On the other hand, the infinitesimal negatively charged electrons, whose diameter has been estimated to be about one sixth-trillion (1-6,000,000,000,000) of an inch, are alike, in every particular. The atoms of the different elements are distinguished by the increasing mass and greater complexity of the nuclear charge, plus a progressive augmentation in the number of the surrounding electrons, the positive central charge determining the spatial arrangement of the revolving or vibrating electrons. A rate of wave vibration has been measured to 762 trillions per second.

The actual size of each kind of atom is not known, but it is assumed that the atoms increase in size with increasing atomic weight, the additional electrons, however, adding little to the total mass of the atom. The increase in atomic weight is due almost entirely to the nuclear charge, or positive ions.

The most remarkable of these phenomena are the properties of the newly discovered and exceedingly rare element of radium, which exists in infinitesimal quantities in chemical combinations from which thus far it could be separated only in the form of radium salts. A little pinch of the salt radiates from its surface myriads of corpuscles possessing the wonderful velocity of over 100,000 miles a second, a velocity sufficient to carry them, if unimpeded, five times around the earth in a second, while the masses of these tiny bodies are a thousand times smaller than the smallest estimated atom known to science. These corpuscles are charged with negative electricity and pass straight through bodies considered opaque, regardless of the properties of the bodies, with the exception of their density. The substances which they strike will shine in the

dark; they affect a photographic plate; they render the air a conductor of electricity, they cause clouds in humid air, and have a peculiar physiological action in the organic world.

Our interest in the effects of radium rays on living organisms will be enhanced by the discovery that radio-activity is widely distributed in nature. It is probable that all plants and animals are adjusted to a normal degree of radio-activity in their environment. Professor J. J. Thomson was the first to discover that the air bubbles in Cambridge spring water became decidedly radio-active. Subsequent researches of numerous physicists have taught us that this property belongs to the water of most deep wells, to freshly fallen rain or snow, to the spray at the foot of waterfalls, to the water of the ocean in certain localities, and probably to all spring waters. The presence of radio-activity in the earth's atmosphere has also been ascertained. The air in the soil is more strongly radio-active than air above the ground. Radio-activity, therefore, must be recognized as a factor in plant environment and plant physiology.

The question now arises: How are the various forms of energy transmitted through space with almost inconceivable velocity? According to the atomic theory, now almost universally accepted, matter, as we know it, consists of an inconceivably large number of small particles, separated by a medium differing entirely from these particles in properties. This medium is known as ether. No ordinary matter is capable of transmitting the undulations or tremors which we call light at a velocity of 186,000 miles an hour. The theory is advanced that ether is a medium of extreme rarity and elasticity diffused through all space from star to star, filling the vast interplanetary and interstellar regions in the universe.

Thus the electronic theory accounts for the different forms of electricity, magnetism, the radiation of light, chemical action, the periodic law of the elements, the phenomena of radio-activity and the physical basis of life. It may ultimately lead to the recognition of the fact that chemical affinity and electrical attraction are one and the same; that the electric force between charged bodies is really chemical action at a distance; and that the chemical combination of atoms and molecules is due to their mutual electrical attraction. The theory is not yet fully proven, but it would appear to serve for the time being as a reasonable assumption that would

account in a plausible way for many phenomena in the organic world.

The late Dr. Wm. Lawrence Woodruff of Long Beach, California, explains the atomic vibration governing cell-life in his book "Therapeutics of Vibration," published in 1907, but which, unfortunately, is now out of print. Dr. Woodruff says in part:

"The cell is the unit of life as the electron is the unit of matter, or, more properly speaking, of force. The cell is made up of a group of atoms, each containing numerous electrons, all in active vibration, and consequently *electronic vibration is the material life of the cell. This being true of one cell, it is true of all.* (The italics are mine.)

"Electronic atomic cell vibration generates a magnetic field individualized for each group of cells forming the different organs and tissues. This is the law of selection or attraction which enables a cell or group of cells to select from the nutrient blood the elements needed for its sustenance and explains why certain groups of atoms are drawn to a cell or group of cells and other groups pass by to be later attracted by other cells, and why the cell debris is thrown off from an uncongenial magnetic field back into circulation, by which it is carried on to the eliminating organs, where it is attracted, appropriated and formed into excretion and thus eliminated from the body.

"The association of the different groups of electronic atomic elements in the cell or group of cells making up a given organ or tissue, means an attunement of unison of the atomic cell vibration with a magnetic atmosphere that is the peculiar property of the organ or tissue, and because of this specific magnetic atmosphere, the organ or tissue has the power of making selections which, speaking in general terms, are always the same. On the other hand, the different groups of cells called organs or tissues must have, within certain definite limits, the same general attunement of atomic cell vibration; for the whole organism must be attuned to the same general key.

"That there may be some departure from the normal in the cell vibration of a certain organ of tissue is true, but this, if long maintained, will speedily effect the attunement of the whole organism. Since the life of the cell is atomic cell vibration, the same is true of the mass of cells that make up the individual, and this being so, there must be a normal and an abnormal cell vibration. A normal cell vibration means perfect health, and abnormal vibration means disease, suffering and ultimate death of the cell and of the mass of cells; or, in other words, the death of the individual.

"Water is one of the principal compounds of the universe. It is also one of the principal elements that go to make up all cell life, be it vegetable or animal. About seven-eighths of all animal tissue is water. A molecule of water is composed of one atom of

oxygen and two atoms of hydrogen. In further analyzing the atoms of hydrogen and oxygen we find they are composed of electrons and nothing else, and the one and only difference between one and the other is that an atom of oxygen contains 11,550 electrons more than does an atom of hydrogen. From this it is apparent that water resolves itself, in an elementary sense, back to the electron, which is the unit of electricity, and is in fact simply electricity and nothing else. I simply use this as an illustration of the point that all matter is electricity, and as an aid in fastening it firmly in the mind.

"The cell being composed of different atomic groups, which are simply masses of electrons always in violent motion or vibration, then the individual life, be it animal or vegetable, is simply a mass of individualized electrical force, always undergoing loss by spending itself in the performance of its functions, always changing its combinations, but always doing so according to fixed laws. Its energy is constantly being radiated into space and to neighboring organisms, and consequently it must be constantly restored to the organism from the different natural elements or atomic groups and neighboring individual organism. Thus, every organism is a collector of and a storage battery for this electrical force, and creates its own magnetic field.

"In obedience to the law of supply and demand, ample provision is made in every organism for the collection and storage of this electrical force. Owing to a too intense life or too rapid radiation or because some one or more of nature's laws is not obeyed, this electrical force falls below the normal. *The point most often neglected is that of supply, for a certain quantity of the material elements must be supplied and appropriated each day to make up for energy lost or expended.* (The italics are mine.)

"A definite quantity of water must be supplied to the system to take the place of that passed off by the skin and kidneys and that given off by the lungs. Going off with the water is a considerable quantity of sodium chloride, and this waste must be made up. This is simply an example of what is taking place with regard to all the other elements, and all these deficiencies must be supplied by fresh material in the form of abundance of pure air, water, natural foods in adequate quantities, and moreover, the appropriation of the substances requires that the atomic cell vibration be sufficiently near the normal to attract them to the cells that are hungering for them.

"Health means absolutely normal function, normal digestion, assimilation and elimination, and this means normal cell-feeding and perfect elimination of debris. All this depends upon normal atomic cell vibration and the other conditions named with it. Anything that interferes with normal cell vibration, normal distribution of the vital stored up nerve forces, or normal voltage causes disease."

It is from this point of view that the study of the characteristics of the elements which make up the organic world becomes highly instructive and interesting. Although the electronic theory is new, attempts have been made already to commercialize it in the treatment of disease by means of doubtful devices. But as all permanent healing must come from within by the restoration of the equilibrium of the vital forces by means of right living, guided by a true understanding of the natural laws, these human makeshifts will be found wanting and soon recognized at their true value.

The eighteen elements which build up the various forms of the vegetable and animal kingdom, also enter into the chemical composition of the human body. They are:

	Symbol	Atomic Weight		Symbol	Atomic Weight
Hydrogen	H	1	Iron	Fe	56
Carbon	C	12	Phosphorus	P	31
Nitrogen	N	14	Sulphur	S	32
Oxygen	O	16	Silicon	Si	28
Potassium	P	39.1	Chlorine	Cl	35.5
Sodium	Na	23	Fluorine	F	19
Calcium	Ca	40	Iodine	I	127
Magnesium	Mg	24.4	Aluminum	Al	27
Manganese	Mn	55	Arsenic	As	75

Oxygen is the only element that enters the living organism in a free state as a part of the air we breathe. Most of the oxygen enters the organisms of plants as water (H_2O) and carbonic acid ($C\,O_2$). The other elements are taken up in more or less complex compounds. Carbon exists only to a very limited extent in the free state, such as graphite and diamond, or in coal, where it is more or less mixed with other substances. Carbon, in chemical combination with lime and magnesia, forms the surface of the earth's crust. All of the carbon is or has been in the form of carbonic acid, and through this compound the element must always pass in its countless combinations. Carbonic acid is taken up by the plants, building with other elements the various food-materials for the animal world and returning free oxygen to the atmosphere. The animals in turn excrete carbonic acid or such waste products from which it is rapidly formed. Thus the balance of oxygen and carbonic acid is maintained in the atmosphere through the exchange of these gases by the vegetable and animal kingdoms.

Hydrogen, which is the lightest of all the elements, occurs very seldom as a free gas. It is one of the constituents of water and, therefore, one of the most essential elements of the organic world.

Nitrogen, forming about four-fifths of the atmosphere, has but a weak affinity for other elements. Only a comparatively small portion of it is found in inorganic compounds, through which it enters the vegetable kingdom. The free nitrogen of the air cannot be assimilated by the plant, except by aid of certain bacteria, which are found at the roots of leguminous plants. The other elements will be treated in Chapters X to XIII, dealing with the so-called organic salts.

We shall briefly consider here the law of conservation of energy, a knowledge of which is necessary to understand the constantly changing forms and positions of matter in the organic, as well as inorganic world.

Over two thousand years ago the Greek philosopher, Heraclitus, conceived the idea that every particle of the universe is in never-ceasing motion, and modern science has verified this theory by demonstrating that motion or energy, like matter, cannot be destroyed.

According to our present conceptions, the sum total of all potential energy and of all kinetic energy in the universe always remains the same. For instance, an electric current represents a certain form of kinetic energy, which is able to split a chemical compound into its elements, by which a part of the kinetic energy apparently disappears, being converted into so-called chemical potential energy, represented in the separated atoms. By synthesis again, the potential energy they contain is again converted into kinetic energy, which appears to us as light and heat, as, for instance, when a flame is produced by the combination of carbon and oxygen.

All, or most forms of energy appearing upon our planet, may be traced back ultimately to one common source, viz., to the waves of heat, light, magnetism and electricity emanating from the sun. Wind and wave, the formation of clouds, the falling rain, the flowing brooks and rivers, the power that turns water wheels, are forms of kinetic energy derived from the potential energy of the sun's heat. Likewise all the material manifestations of plant and

animal life are directly or indirectly derived from solar light and heat.

Plants are constantly taking up carbonic acid and water, separating the oxygen from these compounds and thereby forming other combinations poorer in oxygen and with a great affinity for this element. As carbonic acid and water are fully oxidized compounds, no potential energy is conveyed to the plant by these substances. It is the kinetic energy of sunlight which again separates the oxygen from the carbon and hydrogen in the plant, forming compounds of potential energy. The plant liberates oxygen only in the sunshine and the amount of oxygen set free varies in direct proportion to the intensity of the light. Thus it becomes obvious that all the potential energy stored up in the products of the vegetable kingdom is converted sunlight. The burning candle, the glowing coal, are but sunlight in another form. The immense amount of potential energy lying in the vast coal fields of the earth, which keeps all the wheels of modern industry in motion, is only stored-up sunlight, which once shone upon the primeval forests of ferns and palms millions of years ago.

Animals depend for their food on plants. The oxygen which is liberated from the water and carbonic acid in the plant by the kinetic energy of sunlight, is in the animal body again united with compounds deficient in oxygen, and the ultimate products of this combination are given off as carbonic acid and water, which serve again as food for the plant. The chemical energy of food is thus apparently used up; but we find an equivalent amount of other forms of energy appearing in the animal body, such as animal heat and muscular force. The sum of the work executed by an animal, and of the heat which it gives out, can, therefore, never exceed the amount of the chemical potential energy taken in with its food, and of the kinetic energy of sunlight used in the production of this potential energy by the plant.

The German naturalist, Dr. Max Rubner, has taken up this subject with all the aids of modern science, and has succeeded in demonstrating the exact equivalents between the chemical potential energy taken up by the body in the form of food and the kinetic energy given out by the animal. In his laborious and painstaking work, covering a period of twenty years, and mainly published in his book, "The Laws of Consumption of Energy in Nutrition," he

has shown conclusively that the law of the conservation of energy rules in every department of animal life; that our body-heat, muscular energy and all our perceptible vital functions are transmuted sunlight. It is very probable that our psychical functions, all our feelings, emotions, instincts and ideas are governed by the same law. We know that sensation is excited by a process of movement in the nervous system, and a muscular contraction is the result of an impulse of the will. Thus far, however, we do not possess any exact means of measuring the intensity of sensations, or of any other psychical conditions and processes. Emotions probably far exceed all other mental exertions in the expenditure of energy. We may ascertain that a portion of the brain substance is consumed or oxidized in every mental effort, but we must also consider that the weight of the brain is less than one-fiftieth of that of the body, and that only a portion of the brain is active in mental functions. Even if we were able to measure our psychic forces, such as the will, we might not be able to maintain that they were simply converted potential energy. To be sure, our body is material and can act on other matter, and its energy is mainly derived from the oxygen of the air and food; but the question is whether our will or mind is directing our body's forces along certain lines to achieve desired ends, or whether all our physical and mental activities are dominated by mechanical causes. It seems to the casual observer that energy itself has no directing power and that inorganic matter is impelled solely by pressure back of it, following no preconceived course nor moving towards predetermined ends; as for instance, in case of an earthquake or the eruption of a volcano. On the other hand, may we not assume that life is more than a mere function of matter and energy; and, although dependent on matter for its phenomenal appearance, it is able, to a certain extent, to control or direct material forces? In the small acorn there is already the potentiality not only of one oak tree, but of an entire forest of oak trees; and although the potential energy stored up in an acorn is infinitesimally small as compared with an entire forest, still we cannot maintain that life has generated the smallest amount of energy; it can only guide its transformations according to nature's laws, perhaps supplementing these laws, but in no way contradicting or suspending them.

A human body is formed according to the same laws of evolutionary development as a crystal, a microbe, a plant, a tree. This earth, the sun, our solar-system, the galaxy, all suns and worlds, the stellar universe; the simplest forms of life, the monera and protozoa, as well as flowers, animals and man are not the products of mere chance, the result of blind physical and chemical forces. They are all the expression of preceding stages of evolution, directing the various forms of energy in certain defined channels of unfoldment.

May we then not assume that in the universe there is an intelligence superior to that of man, who is but a speck of dust in infinite space, and whose life is hardly a second in eternity? The human brain, which seems to us the highest organization of matter and energy, is but the result of an all-pervading mind embracing the experience of eons and countless worlds, manifesting itself in the corpuscle, as well as in the largest sun, in the plant as well as in man, always leading onward and upward to higher forms of life and existence.

CHAPTER II

The Problem of Life and Growth

The simplest form of organic matter capable of exhibiting the phenomena of life is called "protoplasm," a word derived from the Greek, *protos,* meaning "first," and *plasma,* "formed substance." Protoplasm possesses a viscous or jelly-like consistency. Under the strongest microscope it seems to be homogeneous, or slightly granulated, like a sheet of ground glass. Not only can it assimilate nutriment and increase in size, but it possesses the power of spontaneous movement and contractility. It enters in a very important manner into the structure of the bodies of the lower animals. As a rule, however, in both vegetable and animal organisms, the specks or clumps of protoplasm assume definite shapes, showing evidence of internal differentiation. In the midst of a minute clump of this substance a sharply defined body called a *nucleus* is formed, which differs from the surrounding protoplasm in not being contractile. When a definite clump of protoplasm contains a nucleus in its interior, it is called a nucleated cell. The cell constitutes, therefore, the first step from protoplasm toward organized existence.

Some of the lowest organisms consist merely of a single cell, others of two or more cells united. The cells, invisible as they are to the naked eye, are composed of billions of molecules, which again have a very complicated atomic structure. It has been shown that a molecule of protoplasm contains several thousands of atoms, giving us an idea of nature's most intricate and wonderful work even in the lowest forms of life.

Cells enter into the constitution of the textures of all higher forms of plants and animals. In the cell we have to search for the source of the vital currents which move the mechanism of the organic world. The most simple cell exhibits all the essential processes of life—nutrition, growth, reproduction, movement, reaction to stimulation. It displays even functions which act at least as a substitute for the psychical powers of higher organisms.

The properties of living matter distinguish it absolutely from

all other substances, and the present state of knowledge furnishes us with no link between the organic and inorganic worlds. The distinctive properties of living matter are:

1. Its chemical composition, containing one or more forms of a complex compound of carbon, hydrogen, oxygen and nitrogen, the so-called "protein," united with a large proportion of water and certain mineral elements, forming the chief constituents of protoplasm.

2. Its universal chemical disintegration and waste by oxidation and its simultaneous reconstruction by new matter. The process of waste resulting from the decomposition or re-organization of the molecules of the protoplasm, breaking them up into more highly oxidated products, which cease to form any part of the living body, is a characteristic of life. Carbon dioxide is always one of these waste products while the others, known as purin bodies, contain the remainder of carbon, the nitrogen, the hydrogen, and the other elements which may enter into the composition of the protoplasm.

3. Its tendency to reproduce itself. In the general course of nature, all living matter proceeds from pre-existing living matter, a portion of the latter being detached and acquiring an independent existence. The new form takes on the character of the substance from which it arose, exhibits the same power of propagating itself by means of an offshoot, and sooner or later, like its predecessor, ceases to exhibit the phenomena pertaining to life and returns its component elements to the universal storehouse of nature.

But in addition to these distinctive characteristics, living matter has some other peculiarities, the chief of which are the dependence of all its activities upon moisture and heat, within a limited range of temperature, and the fact that it usually possesses a certain structure or organization. A degree of heat sufficient to decompose protein matter, if sufficiently prolonged, destroys life by demolishing the highly intricate molecular structure upon which life depends. Recent investigations show that the immediate cause of the arrest of vitality and of its ultimate disappearance *is the coagulation of certain substances in the protoplasm,* and that the latter contains various coagulable matters which solidify at different temperatures, ranging from 140 to 200 degrees Fahrenheit.

There are numerous forms of living matter which it cannot

properly be said possess either a definite structure, or permanently specialized organs; but the simple particles of living matter must have a highly complex molecular structure which is far beyond the reach of physical vision. Thomas Huxley in his "Lay Sermons" gives the following classic description of the physical basis of life:

"Through the tube of my microscope I am watching the development of a speck of protoplasm. Strange possibilities lie dormant in that semi-fluid globule. Let a moderate supply of warmth reach its watery cradle, and the plastic matter undergoes changes so rapid and yet so steady and purpose-like in their succession, that one can compare them to those operated by a skilled modeller upon a formless lump of clay. As with an invisible trowel, the mass is divided into smaller and smaller portions, until it is reduced to an aggregation of granules—not too large to build withal the finest fabrics of the nascent organism. And then it is as if a delicate finger traced out the line to be occupied by the coming spinal column and moulded the contour of the body; pinching up the head at one end, the tail at the other, and fashioning flank and limb into due proportion in so artistic a way that after watching the process one is almost involuntarily possessed by the notion that some more subtle aid to vision than the chromatic would show the hidden artist, with his plan before him, striving with skillful manipulation to perfect his work."

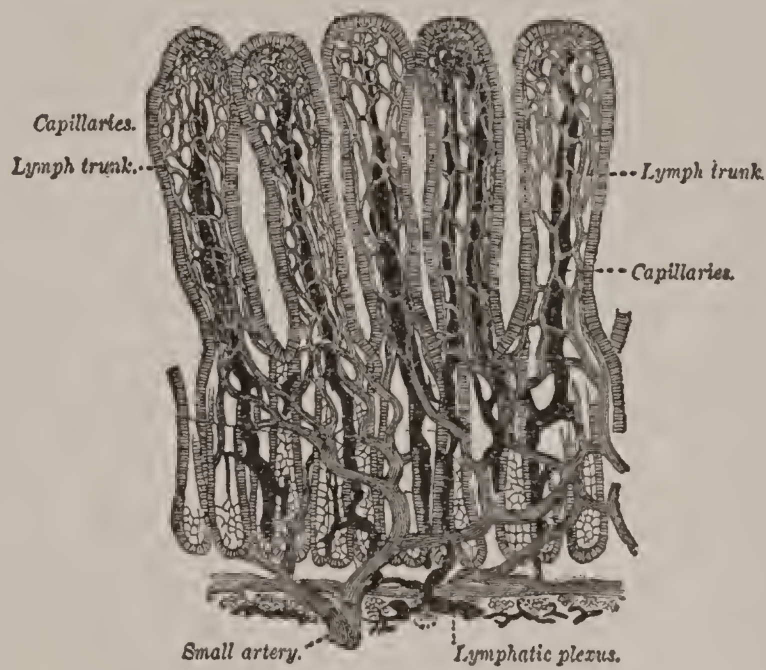
The broad distinctions which, as a matter of fact, exist between every known form of living substance and every other component of the material world, justify the specialization in the study of the problems of life.

We can never expect fully to explain the processes of life by the laws of physics and chemistry alone. The more thoroughly and conscientiously we endeavor to study biological problems, the more are we convinced that even those processes which we have already regarded as explicable by chemical and physical laws, are, in reality, infinitely more complex, and at present defy any attempt at a mechanical explanation.

Careful observations have revealed the fact that all unicellular organisms possess the power of selecting their food, of taking the useful and rejecting the useless. If this power of selecting food is possessed by a structureless mass of protoplasm, why should it not also be a function of the epithelium cells of the alimentary canal? Every epithelial cell is in itself an organism, a live being with the most complex functions.

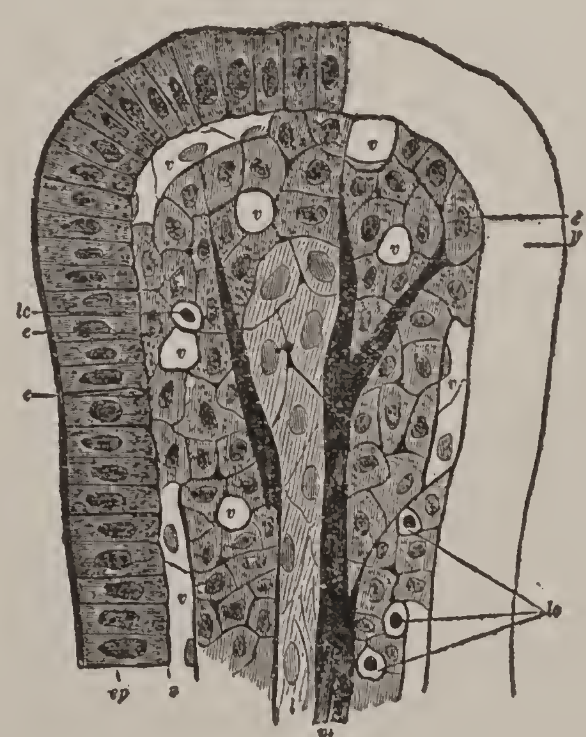
The small intestine, where the bulk of the nutritive material is

absorbed, is covered with minute vascular projections—"villi"—proceeding from the mucous membrane throughout its whole extent. The structure of the "villi," whose total number amounts to about four millions, is indicated in the following illustrations:



Villi of small intestine.

Linear enlargement about 50:1; the dark parts in the middle of each villus represent the lacteals which convey chyle during the process of digestion, while at other times they carry lymph; the lacteals are surrounded by lymphatics and capillary blood vessels.



Diagrammatic section of a villus, showing the cells; linear enlargement about 300:1; *ep*-epithelium (only partly shaded in); *e e e'*-membrane and *tissue-cells; l*-lacteal; *l'*-upper limit of the chyle-vessel; *lc*-lymph corpuscles; *m*-muscle fibres surrounding the lacteal; *v*-blood-vessels; *c*-fine net work (protoplasm) filling out the space between the cells.

All food materials after they have been acted upon by the digestive juices and broken down into simpler compounds, have to pass through the epithelium cells, and the mechanical part of the process called "osmosis," can take place only when a variety of elements is present, so that the ingredients of the fluids on one side of the membranes are different in chemical composition from those on the other side. We can illustrate the process easily by immersing a bladder containing a solution of salt in pure water. In a short time both fluids begin to pass through the membrane towards each other until a uniform solution is attained. The same process is going on in the millions and millions of cells in our body, and without the mineral ingredients in the fluids no change, or hardly any, could be effected, and assimilation and nutrition would come to a standstill.

Thus the mechanical part of food absorption may be explained by the laws of diffusion and osmosis. But the wall of the intestine does not behave like a dead membrane. Every epithelial cell is in itself an organism, a living being with the most complete functioning. These cells prevent the absorption of a whole series of poisons, although the latter may be easily soluble in the gastric and intestinal juices.

The activity of the glands and the processes of secretion show the same wonderful power of selection, of picking out certain constituents of the blood, of altering them by processes of synthesis and decomposition, of sending some into the ducts of the glands, and others back into the lymph and blood. The epithelial cells of the mammary gland collect all the organic salts from the blood which has an entirely different composition, in the exact proportion required by the infant. These phenomena cannot be explained simply by the mechanical process of osmosis.

All of the cells of our body possess the same wonderful powers as the epithelial cells of the alimentary canal and of the glands. All tissues and organs are produced from a single ovum, and in proportion as the cells increase by segmentation, they become differentiated on the principle of the division of labor. Every cell acquires the faculty of rejecting some substances, of attracting others and storing them up, thereby attaining the composition necessary for the proper performance of all the physiological functions in the system. But as soon as life ceases, as soon as the vital

phenomena stop, the ability of selecting substances likewise disappears in every cell of our body. Food itself does not produce life. It only keeps the vital currents flowing, by the chemical and physiological actions of the organism if the food materials are furnished in suitable quality and quantity. If the vital flame which keeps our heart pulsating is once extinguished the finest food and purest air can never light it again. Digestion and assimilation are processes of the living organism and have no analogy in the test tube of the chemical laboratory.

Consciousness is not necessarily and entirely bound up within certain parts of the brain. It manifests or arises by inheritance through a simple cell, from which by repeated division, all of the cells and tissues of our body are derived, including those of the brain and cerebral hemispheres and other parts of the nervous system. The history of the evolution of function should parallel that of the evolution of structure. We can hardly assume that, as we trace the animal kingdom downwards to the unicellular organisms, the conscious life of the individual ceases at that exact point where a brain is no longer present, or even where we can no longer make out a specially differentiated nervous system. May not all life be conscious life; may not consciousness be an inherent attribute of all matter, manifesting itself wherever and whenever the proper physical conditions occur?

Considered apart from the phenomena of consciousness, the phenomena of life are all dependent upon the working of the same eternal, universal laws which govern the rest of the world. The doctrine of evolution compels us to admit that consciousness must be present potentially in the simple protoplasm of the lowest forms of life, and must be present, consequently, in all the tissues of the highly developed animal instead of being confined to some limited portion of the nervous system. All of the parts and organs of the complex animal are the outcome of the differentiation of the primordial protoplasm, and there is no reason why this differentiation, which sets apart the nervous tissue from other parts of the body, should not operate in the nervous tissue itself, developing the rudiments of consciousness present in all nervous material by differentiation, and in that particular kind of nerve substance, the brain cells, which are the seat of some higher form of consciousness. But we must unreservedly admit that very little has been

done towards the final solution of the great problem of life. Of its ultimate cause and innermost workings we know practically nothing. No chemist is able to isolate the life-principle from its original form of manifestation on earth—protoplasm. It is elusive and cannot be determined by the most subtle instruments of the laboratory.

How is it that through a single spermatozoön, through a minute cell, thousands of which would hardly occupy a pin's head, all the physical and intellectual peculiarities may be transmitted from father to son, or even to grandson? How wonderful must be the molecular structure, how complicated the interchange of forces, how intricate the forms of motion, in this small cell which shall direct all subsequent forms of motion and the physical development for generations! And how in this speck of matter—invisible to the naked eye—are the mental qualities evolved? Our present state of knowledge utterly fails to answer these questions.

In the future the problems of physiology will be largely concerned with the structure and evolution of protoplasm. In these investigations inductive reasoning will play a far more important role than the microscope, although the latter may be improved by still more powerful lenses than we have today. Then we may ascertain ultimately the laws according to which protoplasm is built up, as well as the laws according to which it breaks down; for these laws when ascertained will help to explain the wonderful creative work which the protoplasm performs throughout the organic world in the evolution of the amoeba to man.

Future generations may overcome the stupendous difficulties which at present beset physiological investigations, and may come nearer to solving the mysteries of life which now puzzle the minds of the profoundest students of nature. In the meantime, let us not become too dogmatic. There is no reason to believe that the continuous progress of evolution should culminate in the present type of man. Far back in the dawn of the ages, when the primordial sea covered this planet, animal life began in the lowest forms. The time may come when a race of men will develop as superior to ourselves in intellect as we are to our predecessors who inhabited the earth hundreds of thousands of years ago. We are on the threshold of a new civilization, but we cannot enter the promised land until we have made ourselves fit by a more thorough

understanding and practice of the fundamental laws of life, as far as we have cognizance of them today.

There are three factors which are most intimately connected with the problems of life and nutrition, viz., sunlight, air and water. They are most potent factors in the growth and development of the organic world, as will be shown in the two following chapters.

CHAPTER III

Sunlight and Air

Most important for the preservation of health and vitality are sunlight and air. They are just as necessary for growth and perpetuation of life as liquid and solid food. "When the sun does not enter, the physician enters," says an old proverb. It has been found that the greatest mortality occurs in the narrow streets of cities and in houses having northern exposure. The inhabitants of southern mountain slopes are stronger and healthier than those living on the northern sides. Inhabitants of secluded valleys where the sun rises late and sets early, are generally afflicted with peculiar diseases, chiefly due to a lack of direct sunlight and its salutary power to dissipate and decompose noxious vapors which accumulate in dark and low places.

The sun indeed is the great and ultimate source of all power which manifests itself in the inorganic as well as in the organic formations of matter. Plants require sunlight above all, for the completion of their complicated organic combinations. While the lowest species of organic life, such as fungi, are capable of developing in darkness, the higher plants which principally support animal life, always depend upon the rays of the sun for the processes of assimilating the elements of soil and atmosphere. They require especially the non-illuminating, ultra-violet rays, which we know to be most active in the production of electro-chemical effects. Likewise the animal body is to a large extent directly dependent on sunlight for its growth and healthy development. It is a well established fact that, as the result of an insufficiency of light, the fibrine and the red blood corpuscles become diminished in quantity, while the serum or watery portion of the blood is increased, inducing leukemia, a sickness characterized by a great increase in the number of white blood corpuscles. A total exclusion of the sunlight induces the severer forms of anemic diseases, originating from an impoverished and disordered state of blood.

Of the many experiments which have been made so far to demonstrate the beneficial effects of sunlight, that of John Blayton

is the most remarkable and significant. In order to determine whether the indirect or diffused daylight, perhaps during a longer period of time, has the same effect as the direct sunlight, he selected twelve bean plants of the same variety and in the same stage of development. Then he planted them in such a way near one another, that six always had full direct sunlight, while the others received only the diffused daylight. In October the pods were harvested, and the weight of those grown in the shade or diffused light compared with that of those exposed to the sun rays was found to be in the proportion of 29:99; that of the dried beans 1:3.

This result was to be expected, but in the following year, when all the plants grown from the same seed received the full amount of the direct sunlight, the surprising fact was ascertained that those which had been raised in the shade only yielded half the amount of the previous year's harvest, while in the fourth year they blossomed but did not mature. The deprivation of direct sunlight during *one* summer weakened the stock to such a degree that the species became extinct after four years.

The lesson of this experiment may be applied with great benefit to men and their daily habits. The highly beneficial effect of sun-baths, if judiciously taken, is demonstrated by the above example in the best possible manner. A dwelling place which admits the sunlight during all hours of the day, is, therefore, one of the first conditions for the preservation of health. On the other hand, statistics show that the tenement house districts of the large cities to which sunlight has very slight access, have the greatest infant mortality and are perilous breeding places of rickets and tuberculosis. If it were not for the constant renewal of the population from the rural districts, the city dwellers, especially the poorer classes, would die out in the course of a few generations. All mothers should realize the importance of the beneficial action of the sunlight and use every opportunity to admit the direct rays of the sun to their living and sleeping rooms whenever and wherever this is possible. Sunlight and fresh air are primal factors on which the normal development, health and power of resistance of the child depend.

A frequent exposure of the naked body to the sunlight will greatly assist the system in the performance of all physiological

functions. It will especially insure an even distribution of the blood. Such an adjustment of the circulation is necessary for the normal functioning of all organs. People should make it a practice to expose their nude bodies frequently to sunlight and fresh air in order to keep in the best possible physical condition. Public parks should have enclosures wherein light and air baths can be taken, and these should become an adjunct of every modern progressive city. Sunlight is the best germicide, but it also kills the cells of our bodies, if they are exposed too much to the very intense rays of the sun. Moderation and discrimination should always be exercised. Sunbaths are best taken in the morning, and a room with an eastern exposure should be selected for the purpose.

Equal attention should be paid to a continuous supply of fresh air during day and night. Not many persons seem to realize the absolute necessity of the electrifying, life-giving oxygen for the maintenance of vitality and the prevention of disease. It has been only a century and a half ago (1774) since the English scientist, Priestly, and the French scientist, Lavoisier, discovered that we live by means of a chemical process of combustion, in which the blood unites with the inhaled air, yielding the products of combustion which we exhale as aqueous vapor and carbonic acid gas. This chemical action corresponds to that which we find in the case of a burning candle or a lamp fed with oil. If the supply of air is cut off we will be suffocated, just as the flame of a lamp is extinguished if the air is prevented from passing to it. A man may live more than sixty days without food, and a few days without water, but when deprived of air or oxygen, he dies in a few minutes. This proves that pure air is the most necessary of all the essentials of life.

Atmospheric air consists of two gases, viz.: nitrogen and oxygen; the former serves only to dilute the oxygen. Besides these two elements the air always contains some aqueous vapor, carbon dioxide and ammonia. On an average, 100 volumes of air contain:

78.35	vol. of Nitrogen	(N)
20.77	vol. of Oxygen	(O)
0.84	vol. of Water vapor	(H_2O)
0.04	vol. of Carbon dioxide	(CO_2)
0.0001	vol. of Ammonia	(NH_3)
	Traces of other gases (ozone, etc.)	

There are also various kinds of microbes in the air, according to moisture and temperature, causing fermentation and chemical disintegration of organic substances. The composition of air, i. e., its proportions of nitrogen and oxygen, is the same all over the surface of the earth. The degree of moisture or humidity in the air varies according to location and temperature. Carbon dioxide is always present, even in mid ocean and forests, but its quantity is very small, ranging from three to four parts per ten thousand by volume. In closed rooms, however, where numbers of persons are present and at the same time gas and coal are burned, the percentage of carbon dioxide rapidly increases. At the same time the air is filled with other and more poisonous gases, such as ammonia and albuminoid ammonia, while the amount of oxygen is gradually lowered. All these facts should be seriously considered in the proper ventilation of living-rooms, schoolrooms, etc. The following table gives the average amount of carbon dioxide in 10,000 parts found in the air of different localities:

Ocean and forests	0.3
Cities, open streets	0.4 to 0.5
Bedroom during night, window partly open	0.8
Bedroom during night, window closed	1.2
Schoolrooms	1.5 to 3.
Hospitals	2.8
Schoolroom, 70 occupants at close of school hrs.	7.2
Churches, during services	3.5 to 7.
Churches, if heated by furnaces	20. to 30.
Theatres, crowded meeting rooms	25.
Workshops, ill ventilated	30.

These figures show how little attention is paid to proper ventilation and explain the constant increase of pneumonia and similar diseases. The importance of pure air becomes still more obvious if we consider the wonderful anatomical structure of the respiratory organs. The lungs into which the air is drawn, consist of two rounded, oblong, somewhat flattened masses of cellular substance, situated in the cavity of the chest, which communicates with the atmosphere through the windpipe (trachea). The latter, as it descends from the throat, branches off into large tubes, and these branch again and again into smaller and still smaller ones, and finally into hairlike vessels. Through these the air penetrates into the remotest parts of the cellular substance. Around each

visible extremity nearly 18,000 cells are clustered, each of which is connected through these minute tubes with the external air. The cells vary in size. They have an average diameter of about one one-hundredth inch. Their total number has been estimated at about six hundred millions. The wall of these cells is very thin; they are mere air vesicles.

The internal surfaces of all these cells together form an area of about one hundred and sixty square yards of thin cell-wall. Over the whole of this surface minute blood-vessels branch out, almost entirely covering it. Along these tiny vessels the blood continually flows and in its course absorbs through their walls the oxygen of the inhaled air. It is in the delicate membrane of these blood-vessels that the change from venous into arterial blood is effected. The venous blood must be changed continually because it is an impure fluid containing matter that has already served for the support of life in the various parts of the body. Carbon dioxide and other gases are given off, and the oxygen of the air enters the cells of the lungs and is absorbed by the minute vessels which spread over the cell walls. Within these vessels the oxygen combines directly with the hemoglobin of the blood, and by means of the action of the heart, proceeds with it in ceaseless currents through the arteries and veins.

To a certain extent the skin also absorbs oxygen and exhales carbon dioxide, the amount being about one-thirtieth of that excreted by the lungs. Besides, the skin gives off other gases, water and solid matter, amounting to from one to two pounds during the day. In summer people perspire more than in winter. During exercise or exertion more water is lost than when at rest. All parts of the skin should be brought frequently in immediate contact with the external air. There are several million pores in the skin acting as little sewers, through which various waste products of the system are constantly excreted. The clothing and particularly the underwear should be porous, to permit free circulation of the air. Closely woven linen or cotton shirts, if covered with heavy woolen clothes, cause the retention of waste matter which is partly reabsorbed by the system and thrown back on the lungs and kidneys, overworking and weakening these organs.

As has been shown, in ill-ventilated and often tobacco-laden public halls, churches, schoolrooms, theatres and workshops, the

air thrown off from the lungs is rendered still more noxious by the emanations of the skin. People on leaving such places feel the contrast between the inside and outside air and erroneously make the fresh air responsible for their "colds," which are but the result of the inhaled poisonous gases and their unsanitary methods of living in general.

Many persons sleep with closed windows, because they cherish the old delusion that "night-air is dangerous." After a few hours they begin to breathe the exhaled air over again. In the morning they get up with a "tired feeling" and have to resort to "eye-openers" which make their condition still worse. It is during the night when we are at rest that the lungs redouble their efforts to inhale the life-giving oxygen to recharge the human dynamo. It is therefore even more essential to provide for an adequate supply of pure air during the night than in the day time. There is absolutely no danger of "catching cold" from cold, fresh air. On the contrary, the bodily heat, which results from combustion, is increased by an abundant supply of oxygen. A "cold" is really but an effort of the system to cast out impurities, chiefly through the mucous membranes of the throat and nose. Few persons realize that the amount of air taken up by the system daily outweighs that of the solid food.

The changes which have taken place in the composition of the exhaled air are indicated by the following table:

Constituent	Inhaled Air	Exhaled Air
	Volumes per cent	
Nitrogen	78.35	78.85
Oxygen	20.77	16.
Carbon dioxide	0.04	4.35

Exhaled air is also saturated with water vapor and contains traces of ammonia and organic matter varying with the diet, climate and occupation of the individual. Under normal conditions, if the blood is rich in the essential organic salts, the lungs absorb through the medium of the red blood corpuscles twenty-four and one-half ounces of oxygen during twenty-four hours, while they give off twenty-eight ounces of carbon dioxide in the same time. If the blood is deficient in sodium, a considerable amount of car- dioxide is retained in the lungs. Children need relatively

more oxygen than adults, as the tissue changes are more active during the growth of the organism.

The adult man of average weight, at each inhalation draws in about one pint of air, and during twenty-four hours he averages fifteen respirations a minute. Thus he takes in two gallons of air a minute or 120 gallons an hour, amounting to about 2,880 gallons or 384 cubic feet a day. This volume of air would fill a room measuring a little over seven feet in each direction. The weight of this volume is about thirty pounds and contains about seven pounds of oxygen, as the latter forms 23.2 per cent of weight of the atmosphere. Of the total amount of inhaled air the human body takes up oxygen at the rate of 4.78 per cent by volume or 5.25 per cent by weight, while exhaled air contains 4.34 per cent of carbon dioxide by volume or 6.5 per cent by weight.

Of the total amount of oxygen inhaled, the body generally absorbs from eight to ten ounces (one-third) during the activities of day time, while during sleep in the open air, or in well ventilated rooms, the quantity may be doubled to sixteen ounces. It may be noted here, incidentally, that the absorption of oxygen depends largely on the number of red blood corpuscles in a given quantity of blood, a subject which will be treated more fully in another chapter. During severe muscular exertion respiration is also increased in frequency and in depth, and the volume of air exchanged may be from five to seven times greater than during a period of rest.

Experiments have been made by German scientists showing the effect on oxygen consumption of walking on a level and climbing. The following figures give the quantities of oxygen consumed during one minute, the subject being a man of 125 pounds weight:

Form of Exercise	Oxygen Consumption
Standing at rest	16 cubic inches
Walking on a level	48 " "
Climbing	78 " "

It appears that walking increases the consumption of oxygen threefold, climbing nearly fivefold over that consumed at rest. These facts illustrate the influence of muscular activity upon the bodily metabolism and the incidental purification of the system from waste matter. Regular exercise in the open air, during all

seasons of the year, is one of the most important factors for the preservation of health and the prolongation of life.

There is also a remarkable difference in the various species of animals in regard to their need of oxygen. It appears that this need is regulated by the amount of heat generated. The birds, on account of their enormous muscular activity during flight, use up more than the mammals, and the latter require at least from ten to twenty times as much oxygen, in proportion to their weight, as the cold blooded animals. A small animal gives off more heat from a relatively larger surface and consequently requires more oxygen than animals of a larger size, while young animals require more than full-grown animals of the same species. The following table serves to illustrate these differences:

Amount of oxygen consumed in 24 hours, in proportion to one ounce of bodily weight in cubic inches at 32°F.

Sparrow	690	cubic	inches
Duck	100-135	"	"
Dog	65-100	"	"
Man	30- 48	"	"
Frog	4- 8	"	"
Earthworm	7-	"	"
Eel	4- 5	"	"
Lizard, hibernating	1- 6	"	"

The temperature of the air must also be considered in relation to its effect upon our health. Cold air causes a natural exhilaration far superior to the stimulation of any artificial tonic. It is denser and richer in oxygen than hot air. Let us compare zero air and air at 100° F. Since about one-fifth of the air is oxygen, 1,000 cubic feet of air contain 200 cubic feet of oxygen at 100° F. Air increases and decreases in volume as it rises or falls in temperature. For every degree it rises, it increases about 1/500. In 100 degrees it will increase or decrease in volume 100/500 or 1/5. Thus by lowering the temperature of the air from 100° F. to zero, the amount of oxygen it contains will be one-fifth greater. But there is also a decrease in volume, and the 1,000 cubic feet of air will now be 800 cubic feet, containing the 200 cubic feet of oxygen. If we increase this volume of cold air again to 1,000 feet we will have over four pounds oxygen more than in the same volume of air at 100° F. In other words, when we reduce this 1,000 cubic feet to zero, we shall have fifty cubic feet of oxygen, or twenty-five per

cent more oxygen than at 100° F. Consequently when we take in a breath of twenty-eight cubic inches, as we do on an average, we get one-fourth more oxygen at zero than at 100° F., and if we breathe air at 50°, we get one-eighth more oxygen than at 100° F. The degree of activity of our life depends upon the amount of oxygen in our bodies. In hot weather, especially on sultry nights, it is difficult to store up enough oxygen during sleep to replace the amount we lose during the day. But in the cold, dense air of the winter we get a larger supply of oxygen, which makes us more active physically as well as mentally. It is the out-door life in the cool, fresh air of the temperate zones which gives us a strong constitution and increases our resistance against disease. This is the reason why the inhabitants of the temperate zones have more energy and are more advanced than those of the tropics. Today the Caucasians are the foremost among the races of the world, not because they are more or less meat-eaters, as is so often asserted, but because during thousands of years our ancestors possessed the advantage of a cool and invigorating climate, which helped to develop their mental and physical powers to a higher degree. A sound and vigorous body can be produced only by pure blood and healthy nerves. One of the best blood purifiers and one of the most effective nerve-tonics is that which nature has amply provided for all—oxygen, the elixir of life. Procure your full measure of it every day of the year by doing useful work in the open air. It will bring you new strength and vitality and a happy and cheerful attitude of mind.

CHAPTER IV

Water

Water is one of the most characteristic substances of our planet. It may simultaneously appear in solid, liquid and gaseous form; it has been adapted as a unit of measure for the specific gravity of all other substances; it plays an important role in the circulation of the elements in the earth's surface. From oceans and lakes, fields and forests, a continuous stream of water is rising as vapor into the atmosphere, to be recondensed in cooler regions and precipitated as rain or snow. Three-fourths of these precipitations, of course, return directly to the oceans, the rest falling on land, collecting in rivers and lakes or else penetrating the earth, perhaps to be brought to the surface again as springs and wells. When water falls as rain to the earth, it absorbs carbon dioxide, ammonia and other soluble gases, if present, and washes the atmosphere free from dust-particles and impurities. This meteoric water (rain or snow), although nearly free from dissolved mineral substances, is therefore by no means pure, except in very high altitudes and above the line of perpetual snow and ice.

From twenty-five to forty per cent of the annual rainfall in the temperate zones, soaks at once into the ground and passes downward through the soil to hardpan, to clayey or impervious layers, or to rock surface, thence through crevices, broken joints, or glacial drift deposits to the water-table. From here it may flow along the slopes for many miles, until it finds its way again to the surface, either from the bottom of a lake, the bed of a river, the side of a hill or mountain, or supplying wells. Reappearing as spring water it is free from all organic matter, but often rich in gases and minerals. The hardness of most spring-water is chiefly due to its content of calcium bicarbonate which is formed by the action of carbonic acid in rain water upon calcareous materials.

Good water should be clear, colorless, quite free from suspended matter, and yet it should contain small quantities of carbon dioxide and pure air so as to give it a pleasant taste. In its chemical composition it ought to be as free as possible from organic

matter and not contain more than one-thousandth part of mineral matter or fifty grains per gallon. Unless the source of water is above suspicion, the water should be boiled, filtered or distilled. An addition of a small quantity of lime juice or lemon juice has also a purifying influence, on account of its large percentage of fruit acid.

Absolutely pure water can be obtained only by repeated distillations of fairly pure water in vessels constructed of silver. Distilled water, even when stored in porcelain or glass, quickly takes up small quantities of silicates, of which the containers are made. The purest water we can obtain in nature is the rain falling on high mountains, or in the country after several hours of heavy precipitation.

Even rain water contains some minute solid particles, which are necessary for the condensation of the water vapor in the atmosphere, but the earthy matter of rain water is infinitesimal compared to that of hard water. Bacteria are also present in rain water, which should be filtered if to be used for drinking purposes. Rain water is best stored in cement lined wells, as metal poisoning may occur from water stored in galvanized iron tanks. Decaying organic matter increases the solvent power of water for metals, corroding, therefore, the containers and conveyance pipes. We hear of occasional cases of lead and zinc poisoning, resulting from water stored too long in galvanized tanks, which should never be used for this purpose.

All spring waters are more or less hard, the degree of hardness being generally determined by their capacity for dissolving soap. In soft water, such as rain water or distilled water, soap lathers immediately, while in hard water a considerable amount of soap is wasted before any lather is formed. This condition is caused by the calcium salts, carbonates and sulphate of lime, which unite with the fatty acids of the soap to produce new combinations. Only after these salts are chemically combined with the fatty acids can a satisfactory lather be made.

Calcium carbonate in spring-water is formed by the presence of free carbonic acid gas (collected during its passage through the air as rain) which combines with the lime, taken up from the soil. Boiling the water breaks up the calcium carbonate into its component parts. The carbonic acid gas escapes into the air

and the lime is precipitated, but unless calcium carbonate was the only mineral present, the water may still be hard, although less so than before. Chloride of calcium and sulphate of calcium cannot be removed by boiling, and for separating these substances, there is no better remedy than distillation. If a still is used to purify the drinking water, such water, from which a part of the impurities have been removed by boiling or filtering, will not clog or coat the apparatus with lime as readily as very hard waters.

The belief that hard waters are beneficial because they furnish the necessary lime to the human system, and that soft water causes soft bones and premature decay of the teeth, or dissolves some of the necessary elements of the mucous membranes of the stomach and intestines, has no foundation at all. Distilled water will not deprive living tissues of organic salts, as is often assumed.

Lime, to be of any benefit to the system, must be supplied in the organic form such as found in fruits and vegetables. The common practice of giving lime water to babies cannot be justified in the light of modern physiological chemistry. In fact, very hard waters often cause dyspepsia and constipation, which are relieved by the use of soft or distilled water.

Vegetables cooked in hard water are rendered hard and indigestible. This is especially the case with legumes, as the sulphate of calcium in water, when boiled, forms hard indigestible compounds with the legumin, causing flatulency. There is no doubt that the use of distilled water tends to prolong life as it prevents to a large extent the ossification of the arteries and lessens the work of the kidneys.

Dr. Luther L. Von Wedekind of the Navy Yard of Brooklyn, N. Y., who has had wide experience in regard to distilled water, which is used exclusively in the U. S. Navy, writes as follows:

"Any thinking person, medical or lay, who has even a mediocre knowledge of the process of elimination, not only of toxins, but the general run of excrementitious matter from the human body, will at once recognize the therapeutic value of pure water; for if he thinks only a little, he will realize that this surplus of fluid in no way overtaxes the kidneys, but relieves it of its burden by sending to this filter a diluted instead of a concentrated solution, and that the process of elimination by the pores is vastly improved."

It is unquestionable that well aerated distilled water, i.e., is

purified water, is preferable to the usual hard spring waters. Those who live far away from the centers of population, where distilled water can be had at reasonable prices, and are doubtful about their water supply, should procure a small water still for their daily supply of drinking water.

Water is necessary to all forms of vegetable and animal life, even the lowest types. The change of matter which produces human energy is dependent upon the presence of water in the tissues. No vital action is possible without it. It makes up nearly two-thirds of the human body, and the following table gives the percentage of water in its various parts:

Teeth	10.	per	cent
Bones	13.	"	"
Cartilage	55.	"	"
Red blood corpuscles	68.7	"	"
Liver	71.5	"	"
Muscular tissues	75.	"	"
Spleen	75.5	"	"
Lungs	80.	"	"
Brain	80.5	"	"
Bile	86.	"	"
Blood plasma	90.	"	"
Blood serum	90.7	"	"
Lymph	94.	"	"
Saliva	95.5	"	"
Gastric juice	99.5	"	"

The presence of water is essential in the processes of digestion and absorption as a solvent for foods. It is likewise necessary for dissolving the various substances which have to be removed from the body through the excretory organs. More than one-half of the amount of water taken into the system is again discharged through the kidneys, about one-quarter through the skin, seventeen per cent through the lungs and four per cent through the intestines. Thus we are constantly losing water in various ways. The air we exhale is saturated with moisture and the skin is daily giving off from one to two pints of water in the form of invisible perspiration, or in the form of sweat during strenuous exercise. Under normal conditions, the kidneys discharge from two to three pints daily, but there are habitual drinkers of light alcoholic beverages, such as beer, who often consume from eight to ten

pints of liquid during a single day, thus overtaxing and weakening the kidneys and at the same time impoverishing the blood.

The amount of water actually needed by the body depends on various circumstances, principally on climate and occupation. The greater the functional activity of the organism, the greater the need for fluid. This need is indicated by thirst which is best satisfied by pure water, but the larger part of the water necessary for the physiological functions of the system, may be derived from our food, if judiciously selected. Thus fruits contain a very large percentage of water, from 80 to 90 per cent, so that people partaking freely of fresh fruits and vegetables, need little or no water in addition to that supplied by their food. Furthermore, in nature's products, we procure water in the purest form, distilled in her own laboratory, and this is undoubtedly the best and most hygienic way in which water can be taken. Besides, in fruits and vegetables, the water is in an organic combination with other elements and in this state has the most beneficial action upon our system. A person living largely on these foods has very little desire for any liquid. It is only the excessive consumption of meat and other highly seasoned foods which create an abnormal thirst. Certain animals, such as hares and rabbits, which feed on grasses and herbs containing about 85% of water, never drink as long as they can find their natural food. Mother's milk contains about 87% of water, and juicy fruits and succulent vegetables nearly come up to the same standard. A person consuming about four pounds of fresh fruit daily, has in addition to about eight ounces of solid food, at least three pints of water of unsurpassed quality.

As already stated, in case of a high protein diet more water is necessary than with a diet consisting largely of foods in which fats and carbohydrates predominate, because the waste products of the former need a large amount of water for their solution and excretion. We should not, however, entertain the idea that by copious water drinking we are able to flush the system like a sewer. This is a mistaken view resulting from a lack of understanding of the physiological functions of the organism. Purification of the human organism is an electro-chemical process of the living cells. The waste products like uric acid, sulphuric acid, carbonic acid, etc., must be first combined with some of the alkaline elements,

principally sodium, before they can be taken up by the blood stream and excreted. If the diet is lacking in the necessary organic salts, large quantities of water will only complicate matters by thinning the blood and still further reducing its percentage of mineral elements. Similarly, the digestive juices and other fluids of the body will lose their strength. Digestion and elimination will be impaired, while the heart and kidneys will be overworked. On the other hand, a well-planned improvement of the diet will enrich the blood in the needful organic salts and aid the system in the performance of its physiological functions, especially in the more complete digestion of foods and in the excretion of waste matter.

The excessive use of table salt (inorganic chloride of sodium) which is often used as an aid to digestion, cannot be condemned too severely. It creates an unnatural thirst, as it deprives the tissues of a large amount of water on account of its diuretic properties. Moreover, a person who partakes of a beverage, not because he is thirsty, but because that beverage is palatable, is exceeding the actual needs of the system and overtaxing his excretory organs. Indeed, a very large number of people think they cannot quench their thirst with plain water, but must have an ingredient which also pleases the palate. These artificially acquired cravings, largely due to wrong eating, are responsible for a good deal of over-drinking with its fatal consequences. The thirsty person who cannot satisfy his thirst unless the beverage contains what is really a drug, has actually acquired a most pernicious habit. Among such unhygienic drinks can be classified the various intoxicating beverages, even if containing but a small percentage of alcohol, and coffee, tea, soda water and the numerous carbonated drinks which are dispensed at soda fountains and refreshment counters. All these drinks, when consumed regularly, convey something into the organism over and above the water itself, something that is not only distinctly injurious to the system, but that also offsets the beneficial action of the water. Furthermore, alcoholic beverages stimulate the kidneys to excessive excretions of urine which constantly carry off necessary mineral elements from blood and lymph.

All fluids have to pass through the blood-vessels of the stomach and the lacteals of the small intestine to the thoracic duct which

passes upward along the front of the spine and opens at the root of the neck into the large blood-vessel leading to the heart. From here the blood stream passes to every part and organ of the body, nourishing and cleansing the cells and forming digestive juices and glandular secretions. The organic salts in performing their functions use up vital electricity and magnetism, and must be renewed by means of natural food. Mineral waters, coffee, tea and alcoholic beverages do not supply these salts, but still further vitiate the already impoverished blood and lymph. In all such conditions an exclusive fruit diet will be more beneficial than the taking of one or two gallons of liquid daily, for which there is no physiological need.

There also exists a wide-spread and entirely unfounded notion that the salts contained in mineral waters supply the elements for the proper physiological functions of our organism. Careful investigations have shown repeatedly that inorganic substances, like lime, soda, potash, iron, silica, etc., contained in these waters, while they may enter into the circulation and produce some temporary chemical action, are not able to perform the vital processes in place of the highly organized salts of natural foods. The wonderful cures reported from renowned watering places, must be attributed to the increased exercise in fresh air and a more or less restricted diet, rather than to the copious drinking from certain springs. Most of the mineral waters which are used as aperients give only temporary relief and, if regularly taken, produce a catarrhal condition of the alimentary canal. Pure water, with the addition of some unfermented fruit juices, is far more beneficial in such cases, as the mild organic acids of the fruits promote the normal action of the digestive organs and help to overcome constipation.

As already pointed out, the best way to regulate the water supply of the system, is to adopt a simple and frugal diet, free from inorganic salt, spices and condiments, but with a liberal supply of salad plants and fresh fruits. Thus the desire for liquids will be greatly reduced and, whenever thirst occurs, it will be natural and best satisfied with pure and soft water in moderate quantity.

If liquids for which there is no physiological need, are habitually taken into the system it is certainly not in accordance with the laws of hygiene. No strict rules in regard to the quantity of

water can be made, except that drinking during meals should be avoided, or at least reduced to a minimum. If there is an indication of thirst, the meal should consist largely of fresh fruit. Ice water should never be taken, and the temperature of drinking water should never be much below 50° Fahrenheit. When the use of hot water is required internally, the temperature should be between 110° and 120° Fahrenheit, or slightly above blood heat.

CHAPTER V

The Constituents of Food

The problem of proper nutrition is a very important one in the life of the single cell as well as in the complicated organism of higher plants and animals. The scientific study of this subject is comparatively new. The first effective impulse to systematic investigation of the chemistry of foods was given by the German scientist Baron von Liebig about seventy years ago. It is only within recent years that we have acquired definite knowledge of the chemical composition of foods. No one knew formerly, except in a very crude way, of what our bodies and our foods were composed and how the different chemical elements served their purposes in nutrition. Even today the majority of otherwise intelligent people know but little about what their food contains; how it nourishes them; whether they are economical or wasteful in buying and preparing it for use, and whether or not the food is suitable for the actual needs of the body.

The physical manifestations of animal life depend primarily upon the electric and magnetic power stored up by the sunlight in the complex organic compounds of the vegetable kingdom. All food for men and animals is directly or indirectly the product of vegetable life. The process of digestion splits these compounds into simple organic forms, thereby setting free the latent electric and magnetic energy stored in the food and transferring it to our system. The building of the tissues proceeds according to the general law of life and growth, which is founded on the impulse to form new cells and to renovate or change old ones. In other words, nutrition is essentially the attraction and assimilation of a certain amount of new matter by the cells of the body, with the simultaneous removal of substances which have expended their vital energy.

To insure perfect and healthy nutrition food should contain all the eighteen elements which are essential to make up the body. Furthermore, these elements must be furnished in organic combinations and in certain well-defined proportions, as they exist in natural food products. Life cannot be maintained by proxi-

mate food principles extracted artifically from natural foods, as, for instance, pure gluten separated from the wheat kernel, refined sugar extracted from the sugar beet, and the many manufactured products which flood the market. Crude minerals, such as lime, magnesia, table salt, etc., are likewise unable to build the living tissues of the human body although they may produce some purely chemical reactions. Still less can the elements as proximate principles serve in the processes of nutrition. Organized by nature in the highly complex compounds of fruits and vegetables, phosphorus, sulphur and chlorine are assimilated and beneficial; but in their elementary state they are injurious and even deadly poisonous to the system.

The oxygen we breathe is the only element which is taken up in the uncombined state by the body. As such, however, it does not become an integral part of our tissues, but only enters in a loose combination with the hemoglobin of the red blood corpuscles, in which form it is the most productive source of energy.

Although the chemist is able to build up artificially a series of more or less complex organic compounds, his experiments do not represent the synthetic processes in the living cell. All of the so-called organic substances coming from the laboratory are produced by the application of forces and agents which can never play a part in the vital processes, such as extreme pressure, high temperature, strong galvanic currents, etc., agencies which would be immediately fatal to a living cell. To take an extreme case, how can a chemist imitate a wheat-kernel? No amount of analysis and subsequent synthesis will enable him to do so. For, though he should succeed in forming the simpler organic combinations in their due proportions, and even imitate the more complex compounds, still there would be lacking the life-principle with its power of reproduction, which would utterly defy his efforts. There are in nature's organic products subtle qualities which are not susceptible to chemical analysis, and these are too volatile to survive the laboratory process of condensation and extraction. The ingredients revealed by the material analyses of foods, are believed to be essential constituents. Here, too, it is probable that these ingredients are not the most valuable, but only the coarser part. Manifold as they seem, the material manifestations of animal life have but one origin, viz., the oxidation of complex organic sub-

stances, and but one object, viz., vital electricity, with heat and muscular energy as by-products.

The continual setting free of energy, peculiar to the living body, entailing as it does the ceaseless breaking up of various substances, constitutes a drain upon the system which must be met by constantly renewed supplies; otherwise the body would waste away and its energy diminish. Hence, the necessity on the one hand for food, or those substances which are a source of energy, and which replace the lost constituents of the body; and on the other hand, for pure air which supplies oxygen and may be classed among the foodstuffs. The air combines with the organic substances, reducing them at the same time to simpler molecules in the processes of oxidation or combustion, by which potential energy is turned into kinetic energy. Food, of itself, can exhibit energy as heat only with intervening phases of chemical action. Before its energy can be turned into the various forms of nervous and muscular action, it needs to be transmuted into blood and lymph, and in that transmutation there is a preliminary expenditure of a part of the food's store of energy. Part of the potential energy, in other words, of the food is used up in digestion and assimilation. The nutritive value of food is, to a certain extent, determined by its digestibility. The energy furnished by a given amount of food is measured by calories; one calory representing the amount of heat which would raise the temperature of one pint of water four degrees Fahrenheit. The number of calories of a certain food product, however, cannot determine its dietetic and hygienic value. As already mentioned, the potential energy of foodstuffs, as utilized by the heart, and the nervous system, is not only due to the production of heat, but also to the electric, magnetic and other imponderable forces stored up in the highly organized molecules of food. *In point of fact, the principal role of food is not simply to be digested and oxidized, as present-day physiology assumes, but to supply vital electricity and magnetism, and these are best obtained from the various products of the soil, which should not undergo much, if any, artificial preparation.* A pound of white flour has 1,635 calories; a pound of refined sugar has 1,750 calories, and a pint of whiskey about the same. Yet none of these substances if used exclusively can maintain life for any length of time. Indeed, they would destroy life sooner than total abstinence

from all food, as they rapidly break down the cells, by depriving them of their alkaline elements.

While there are more than a thousand different food-products, their constituents or proximate principles are always about the same, although they are found in varying proportions. We shall here briefly enumerate these constituents and deal with them more explicitly in the following pages.

Water, composed of hydrogen and oxygen, is contained in varying percentages in all natural foods. It is indispensable as a solvent in all the physiological functions of the body and of every form of life.

Nitrogenous compounds, chiefly found in the form of *protein,* are composed of carbon, oxygen, hydrogen, nitrogen and sulphur. They rebuild the wear and tear of the tissues and furnish, also, some potential energy when there is more supplied than needed for functional purposes. The protoplasm of both the plant and animal cell is composed mainly of protein. Protein, again, exists in different forms, such as the *albumen* of eggs, the *casein* of milk, the *gluten* of cereals, the *legumin* of pulses, etc. Similar to protein in chemical composition are the *gelatins* which, however, do not assist in repairing the waste of the tissues, but serve as a source of heat and energy. About fifty different proteins have been sufficiently isolated and studied. Their nitrogen content ranges from 15.50 per cent in egg albumen to about 18 per cent in gluten, found in wheat and other cereals. The *amino acids* are nitrogenous compounds of simpler structure than the proteins. Seventeen different kinds have been determined so far. In the construction of the protein molecules of plants, nitrogen is absorbed from the soil in soluble forms, as compounds of nitrates and ammonium salts, which are converted first into amino acids and then into protein. The reverse takes place in the animal body, where the protein molecule is again broken up into simpler compounds such as amino acids, and is finally transmuted into ammonia, urea, uric acid, etc., which, in the open air, undergo oxidation and re-conversion into nitrates and ammonium salts, ready to be taken up again by the plant.

The non-nitrogenous compounds exist in the form of *carbohydrates* and *fats,* and are always composed of the same three elements: carbon, hydrogen, oxygen.

The carbohydrates are chiefly products of the vegetable kingdom, such as sugars, starches, cellulose, gums, pectins and dextrins. In the milk of mammals, however, we find a considerable amount of carbohydrates in the form of milk sugar. Carbohydrates are not directly required, like protein, to build up or repair the cells of the body, but they are readily oxidized by the inhaled air into carbon dioxide and water, furnishing heat and energy to the system with the greatest vital economy.

Fats are found mainly in the seeds of plants and to some extent in the leaves, skins and fruits; they are also found in most of the animal food products. Fats are deficient in oxygen and rich in carbon and hydrogen. Consequently their heat-equivalent is much greater than that of the carbohydrates. The latter yield 1,820 calories per pound, the former more than twice as much, or 4,040 calories.

The fats and the carbohydrates may replace each other, but only within certain limits. They do not appear to play exactly the same part, although composed of the same elements. The fact that fat is contained in the milk of all mammals, in the eggs, and in all seeds of plants, seems to demonstrate that it is an indispensable food constituent. It is further proved by the instinctive desire for the addition of fat to a diet, however abundant in carbohydrates it may be, and the desire, on the other hand, for the addition of carbohydrates to the richest fat diet.

To the non-nitrogenous compounds also belong the organic acids of the vegetable kingdom, such as tartaric acid, citric acid and malic acid, which are likewise oxidized into carbon dioxide and water, supplying heat and energy to the system.

While carbohydrates and fats cannot replace protein, a deficiency of nitrogen is made good, to a limited extent, by the protective agency of the other foodstuffs which offer themselves for all the purposes except the final one of tissue building. The fat of all foods is very completely absorbed, far more so than the protein. The same is true of all carbohydrates, with the single exception of cellulose.

The *vitamins* or life elements, whose chemical composition is not yet fully known, are present in all natural foods. They are intimately connected with the processes of life and growth, but

they can be active only when all the body-building elements are present.

The *organic salts* play the most important part in our nutrition. In articles on foods and tables of food-contents, they generally figure under the collective names of mineral matter, ash, or inorganic foodstuffs, without any attention being paid to their elementary composition. Their study has been woefully neglected by the majority of physiologists, who have treated them as a subject of little importance. We are often confronted with such statements as these: "The part which each of the mineral elements takes in animal nutrition is not well understood," or "With the ordinary mixed diet the body demands for mineral matter may be met," *but as long as the importance of the organic salts in our system is not recognized and understood, just so long will there exist such deplorable guesswork, both with regard to diagnosis and to the treatment of disease.*

Physician and patient quite often resemble "the blind leading the blind" and, indeed, the blinder the members of the medical profession are, the more instruments do they need in their practice. They come armed with the microscope, laryngoscope and a chest of re-agents. They discover germs and bacilli, and invent serums, vaccines and antitoxins. They do not yet understand that the real and ultimate cause of disease is beyond the reach of the microscope; that the origin of all so-called diseases lies in the diminished vital electricity of the cells, with a corresponding reduction of the nerve power and lowering of vital resistance, resulting from faulty nutrition, especially from eating emasculated foods, deficient in organic salts. The organized mineral elements in the natural foods are essentially the preservers of all the tissues, giving them stability and power of vital resistance. To the degree they are lacking in our food or are not supplied in the proper proportion and organic combinations, we are susceptible to injurious influences.

The mineral constituents of the body are potassium, sodium, calcium, magnesium, iron, manganese, phosphorus, sulphur, silicon, chlorine, fluorine, and minute quantities of iodine, arsenic and aluminum. They enter the system as fully oxidized compounds, and as such furnish little or no potential energy. But they are indispensable in the performance of all the physiological functions

of the system, in the processes of digestion and assimilation, secretion and excretion and in the purification of the blood from waste matter. They are most essential for the healthy and normal growth of the organism and may be truly called "the building stones of the body."

To enjoy perfect health and immunity from disease, our blood must contain all the necessary elements in their wonderful combinations; because it is the blood which carries them to the different parts of the body, nourishing and cleansing the tissues, creating animal heat, magnetism and electricity.

In recapitulating the different constituents of food, we may divide them into three classes:

(1) Those which replace the worn-out tissue elements of the body and at the same time supply heat and energy, such as proteins and fats;

(2) Those which supply heat and energy only, such as carbohydrates, gelatins and the inhaled oxygen of the air;

(3) Those which repair only the worn-out tissues, such as water and organic salts, the latter through their electro-magnetic properties being most essential in all the vital functions of the organism. The organic salts are of as great importance to the animal and human organism as the proteins, fats and carbohydrates.

As previously mentioned, no proximate food-principle alone is able to sustain vital force in the animal organism, and the above division is merely provisional. Fats may be placed in the first as well as in the second class, while gelatins and carbohydrates may indirectly assist in the building up of cells, by protecting the tissues from decomposition and oxidation.

In the subsequent pages the different food-constituents will be considered more elaborately.

CHAPTER VI

Proteins

Proteins are never absent from the protoplasm of acting living cells, whether animal or vegetable, and they are indissolubly connected with every manifestation of organic activity. Proteins are highly complex compounds of carbon, hydrogen, nitrogen, oxygen, and sulphur, occurring in a solid or viscous condition or, in solution, in nearly all the solids and liquids of the organism.

In vegetables the proteins are constructed out of the simpler, chemical compounds which serve as plant food. In animals such a synthesis never occurs, but the proteins are derived directly or indirectly from vegetables.

The principal *vegetable proteins* are:

Albumen in fruits and soft, growing vegetables
Gluten in wheat and other cereals
Legumin in peas, beans, lentils, etc.
Globulin in legumes and nuts
Nucleo-protein in the germs of seeds

Some of the *animal proteins* are:

Casein in milk and cheese
Albumen in the white and yolk of eggs
Myosin in the flesh of animals
Serum, albumen and fibrin in the blood
Gelatine in bones, collagen and tendons
Nitrogenous extractions in creatin, and allied compounds

In the process of digestion the protein molecule is broken up into simpler compounds, among which the most essential are the amino acids. Experiments have shown that they pre-exist in the protein molecule and are not formed during the digestive process. Amino acids are crystallizable and do not show the colloidal character of the protein molecule and are therefore, easily dissolved. While all proteins yield amino acids, the proteins differ from one another chemically in the amount of different amino acids they contain. In the processes of life and growth the animal body builds its own protein, tissues, and organic matter, which in each

organism have an architecture as distinct and characteristic as the form of the organism itself.

Experiments show, that by the decomposition of protein into amino acids very little energy is expended; hence, only a very small amount of energy is required to reconstruct or renew the tissues of the body.

Attention should be paid to the fact that the nutritive value of protein, or of a mixture of proteins, depends upon the presence in its molecules of all the essential amino acids and upon the extent to which their proportions correspond to those existing in the body proteins, as one kind of protein may supplement the deficiency of another. It is, therefore, desirable to include in one's diet a variety of foods, not of course to be eaten at the same meal, but varied from day to day, from week to week, and from month to month, such as are furnished by nature in the course of the seasons.

The various proteins differ somewhat in elementary composition, within the limits of the following figures:

Carbon	(C)	50.	to	55.	per cent
Oxygen	(O)	19.	to	24.	" "
Hydrogen	(H)	6.6	to	7.3	" "
Nitrogen	(N)	15.	to	19.	" "
Sulphur	(S)	0.3	to	2.4	" "

A few of the vegetable and animal proteins have been analyzed and their highly complicated atomic structure is indicated by the following formulas:

						No. of Atoms in the Molecule
Egg-albumin	C_{204}	H_{322}	N_{52}	O_{66}	S_2	646
Globulin from pumpkin seeds	C_{292}	H_{481}	N_{90}	O_{83}	S_2	948
Protein in hemoglobin of horse	C_{680}	H_{1098}	N_{210}	O_{241}	S_2	2231
Protein in hemoglobin of dog	C_{726}	H_{1171}	N_{194}	O_{214}	S_3	2308

It appears that the proteins in the various species of plants and animals have a different atomic structure and arrangement, and even among the same species there seems to be a difference in that respect, which is, to a certain extent, reflected in the physical development of the individual. A very serious mistake is often made by valuing all proteins alike. For instance, the amount of pro-

tein in meat is calculated according to amounts of nitrogen it contains, multiplying this amount by 6.25; but we find in meat a considerable quantity of gelatinous substances, which have a totally different action in nutrition from that of protein. Artificial preparation, like cooking or frying, diminishes the nutritive value of proteins to some extent, a fact which should be also considered.

Again, the proteins derived from fresh fruits and vegetables, also those from uncooked milk, are associated with a greater amount of alkaline elements which, from a hygienic point of view, make vegetable proteins superior to those obtained from flesh foods.

The nucleo-proteins, so called because they occur in the nuclei of cells, generally contain a small amount of phosphorus, while hemoglobin, a protein compound constituting the red coloring matter of the blood, contains, besides sulphur, about 0.3 per cent iron, two atoms of sulphur combining with one of iron.

The fibrous tissues of animals, such as are found in bones, tendons, and ligaments, contain a substance known as collagen, which, when boiled in water, is transformed into gelatine. The percentage composition of the varieties of gelatine is nearly the same as that of the proteins. The former are somewhat poorer in carbon and richer in oxygen; they are products of the beginning of the breaking up and oxidation of the proteins in the animal body, consequently the heat equivalent of gelatine is lower than that of the proteins. Experiments have shown that no protein can be produced from gelatine, although we know that all gelatine-yielding tissues are formed from protein. But if to a small amount of the protein in the food, which was not in itself sufficient to prevent a loss of tissue-protein, gelatine was added, the nitrogenous equilibrium was restored. The gelatine, therefore, had preserved the protein of the tissues from decomposition. This protein-sparing action is also shared by fats and carbohydrates, but not in the same degree as by gelatine.

Since muscle consists chiefly of protein, the early students of physiology supposed that this substance was the source of muscular energy. This view was first maintained by Baron von Liebig who contrasted the foodstuffs containing no nitrogen (the fats and carbohydrates), which he named "respiratory foods," with the proteins, which he termed "plaster foods." He believed that the former served mainly to generate heat, while the latter were indis-

pensable for the production of energy. Today we know that in muscular work, the excretion of nitrogen is increased only to a very slight degree, but that the excretion of carbonic acid and the absorption of oxygen is notably increased; that, therefore, muscular energy is mainly derived from non-nitrogenous substances. A portion of the carbon and hydrogen of the protein molecule will be oxidized within the body, but there remains a nucleus of nitrogen, with some carbon, hydrogen and oxygen, which resists combustion and must be excreted by the liver and kidneys. In physical exercise, when foods rich in proteins are the sole source of the energy of muscular contraction, the work accomplished results from the direct oxidation of carbohydrate material, indirectly derived from the protein molecules. But for the normal man this process is far less economical physiologically than the direct utilization of carbohydrate and fat, introduced in the form of natural foods, such as fruit, nuts, cereal or vegetable products in proper combinations, furnishing sufficient protein to meet the ordinary nitrogen requirements of the body. While an increase in the protein may assist in building new tissues, the source of muscular energy is to be chiefly found in the oxidation of the non-nitrogenous materials, carbohydrate and fat.

It has been one of the physiological dogmas of the past that the tissues and organs of the body, or rather their constituent cells, must be supplied with protein for all their functions whenever it was available. The remarkable fact that the output of nitrogen is equivalent to the intake of protein; that the body cannot store up nitrogen to any considerable extent, has been taken as conclusive evidence that the organism prefers to use protein for most of its requirements. We may with more valid reason argue that the large and significant increase in excretion of nitrogen, after partaking of foods rich in proteins, is an indication that the body has no need of this excess of nitrogen; that it is really a possible source of danger, since the system immediately rids itself of the surplus, involving a needless waste of vital energy.

The metabolism in the body usually takes place in the active tissues, but, according to our present knowledge of the matter, it does not seem to occur at the expense of the protein in living cells. In other words, it is not the protein incorporated in the cells that undergoes change, but the protein circulating in and about the

internal meshes of the cells and tissues, the living cell being the active agent in controlling the process. This view readily explains the elimination of nitrogen after a meal rich in proteins, as a means of excreting a surplus of food elements for which the body has no need.

As the protein changes into blood and lymph, the fluids bathing the cells are correspondingly enriched, and as a result the breaking down of protein molecules is accelerated to the same degree. The protein organized in the cell is never decomposed directly. It must first undergo cleavage, and then under the influence of the living cells it will be changed into carbonic acid and urea in the same manner as the circulating protein. It is evident that an excess of the latter will be attended by an increased excretion of nitrogen in the form of waste products, while at the same time there may be some accumulation of protein in the cells, and consequently some conversion into superfluous tissue. During fasting, or with an insufficient intake of protein, the current will naturally be in the opposite direction, and the organized proteids of the cells will slowly but surely be drawn upon. A small amount of protein (one to two ounces) will always be necessary to supply the loss incidental to tissue waste, but beyond this requirement there is no real need of protein. We may compare, to a certain extent, the tissues of the body with the structure of an engine which wears out very slowly, while fresh fuel for power must constantly be supplied.

The physiological fuel value of protein, containing as it does from fifty per cent to fifty-five per cent of carbon, is not greater than that of an equal amount of sugar or starch, and considerably less than half that of fat. Consequently, there is no reason why protein should be used for its energy-value in preference to the non-nitrogenous foodstuffs. As already indicated, muscular energy is mainly the result of the direct oxidation of fat and carbohydrates, while in the breaking down of protein molecules a large proportion of nitrogenous matter has to be split off and disposed of before the carbon molecule can be rendered available. This process involves not only a loss of energy, but, in addition, a certain amount of useless labor is thrown upon the liver, kidneys and other organs. The greater part of the protein included in so-called standard diets is not needed. In order to make use of the carbon

contained in the protein molecule, the organism is forced to temporarily put extra work upon the excretory organs.

The numerous dietary studies made in the United States and Europe do not throw light on the hygienic aspect of the food problem, especially on the proper selection and combination of foods. The usual bill of fare is not an index to the normal needs of the body, but rather to the morbid cravings of perverted appetite. The quantity of food consumed, moreover, is by no means a safe indication of the physiological requirements of the body. Eating three or four meals a day has become a habit with many people; and as meat, cereals, eggs or dairy products constitute the greater part of the dietary, a large quantity of protein is consumed for which there is no actual need. No intelligent person can maintain that the enormous consumption of meat, alcohol, coffee and tea indicates a true physiological requirement. Civilized man lives to eat instead of eating to live, and the majority of people will contemptuously reject any advice of moderation, until, after years of over-indulgence, they find themselves in the grip of chronic disease. The actual requirements of the body can never be determined accurately by what the average person eats and drinks, or by his instincts, but only by the knowledge resulting from a careful study of the physiological functions of the body.

As early as 1887 experiments were made in Germany which demonstrated that the amount of protein used could safely be reduced to 40 grams (1½ ounces), or to about one-third of the usual amount of 120 grams (4½ ounces). Later investigations confirmed the results of these experiments. But the old standards of Liebig and Voit had been so firmly established in the minds of the medical profession, that these experiments merely excited comment without changing to any extent the prevalent belief of the necessity for large amounts of protein to maintain health and strength.

In the United States extended experiments have been made by Professor Jaffa of the University of California at Berkeley, and by Dr. Russell H. Chittenden of Yale University at New Haven, Connecticut. Professor Jaffa's report of investigations made among a number of fruitarians, contains an interesting account of a dietary study of a family of fruitarians, consisting of two

women and three children. They had all been fruitarians from five to seven years, their diet consisting chiefly of fruits and nuts, with the addition of celery, honey, olive oil, and occasionally a small amount of prepared cereal food. This family was in the habit of taking only two meals a day, at 10:30 in the morning and at 5 o'clock in the afternoon. The first meal always consisted of nuts and fruit, the nuts being eaten first. At the second meal, nuts were usually replaced by olive oil and honey. The nuts used were almonds, Brazil-nuts, pine-nuts, pignolias and walnuts. Fruits, both fresh and dried, were used, the former including apples, apricots, bananas, figs, grapes, olives, oranges, peaches, pears, plums, and tomatoes. The dried fruits were dates and raisins.

On this frugal diet, which consisted chiefly of uncooked foods, excluding all animal foods and legumes, this family with three growing children had lived in good health all these years. All the members of the family were put under observation for about three weeks. The food consumed was carefully weighed and its chemical composition determined. The average amount of food consumed per day was: 33 grams (1⅕ ounce) of protein, 59 grams (2 ounces) of fat, 150 grams (7⅓ ounces) of carbohydrates, with a total of about 11 ounces of solid food.

The results of the experiments are summarized in the table below, which for purposes of comparison includes the results of Voit's experiments on a man living on bread, fruit and oil. The table also gives the results of a number of American dietary studies, as well as the still commonly accepted standards for a man and a woman taking moderate muscular exercise. The figures give the daily amount consumed (28 grams (metric system) are equal to one ounce).

	Years	Weight	Cost, cents	Protein, grams	Fat, grams	Carbo-hydrates, grams	Ratio of protein to fat and carbohydrates
Woman	33	90 lbs.	23.1	33	59	150	1-8.6
Woman	30	104 lbs.	17.2	25	57	99	1-9.1
Girl	13	75 lbs.	19.0	26	52	157	1-10.5
Boy	9	43 lbs.	19.9	27	56	152	1-10.3
Girl	6	30 lbs.	17.0	24	58	134	1-11.
Girl	7	34 lbs.	27.5	40	72	134	1-7.4

Other Dietary Studies	Protein, grams	Fat, grams	Carbo-hydrates, grams	Ratio of protein to fat and carbohydrates
German vegetarian (Voit)	54	22	573	1-11.6
Average of 53 investigations of well-to-do families in the U. S.	103	138	436	1-7.3
Old Dietary Standards				
Man with light muscular work (Atwater)	112			1-5.8
Man with moderate muscular work (Voit)	118	56	400	1-5.3
Man with moderate muscular work (Atwater)	125			1-5.8
Woman with moderate muscular work (Atwater)	90			1-6.1

The experiments as a whole show very small amounts of protein, ranging from 24 grams (⅞ ounce) to 40 grams (1½ ounces) per day, while Atwater's standard referred to above for a man at light muscular work calls for 112 grains (4 ounces) of protein. The nutritive ratio (protein to fat and carbohydrates) of the old standards ranges between 1-5 and 1-6, that of the fruitarian dietaries between 1-7.4 and 1-11. For the adult man a nutritive ratio of 1-10, or even 1-12, would be adequate, which means that the main bulk of our food supply, whether we are vegetarians or not, should consist of fresh fruits and vegetables, preferably those which can be eaten in the uncooked state. Says Professor Jaffa regarding the foregoing fruitarian dietaries:

"It would appear upon examining the recorded data and comparing the results with commonly accepted standards, that all the subjects were decidedly under-nourished, even making allowance for their light weight. But when we consider that the two adults have lived on this diet for 7 years, and think they are in better health and capable of more work than they ever were before, we hesitate to pronounce judgment. The three children, though below the average in height and weight, had the appearance of health and strength. They ran and jumped and played all day like ordinary healthy children, and were said to be unusually free from colds and other complaints peculiar to childhood."

Likewise, a number of German scientists have reported experiments with subjects on vegetarian, as well as mixed diets, furnishing much less nitrogen than the commonly accepted standards call for, and have found that the nitrogen equilibrium can be maintained with small amounts of protein food.

Most interesting and valuable are the systematic experiments conducted by Dr. Russell H. Chittenden at Yale University with a number of professional men and a detachment of twenty men from the Hospital Corps of the U. S. Army. The investigations, which were especially made to determine more closely the nitrogen requirements of man, covered many months and are fully described in Dr. Chittenden's works, "The Physiological Economy of Nutrition" and "The Nutrition of Man." The dietetic habits of all the men were in accord with common practice and their daily consumption of protein averaged from four to six ounces, which was gradually reduced to about two ounces. Says Dr. Chittenden:

"The experimental results presented afford very convincing proof that so far as body-weight and nitrogen-equilibrium are concerned, the needs of the body are fully met by a consumption of protein food far below the fixed dietary standards and still further below the amounts called for by the recorded habits of mankind. General health is equally well maintained, and with suggestions of improvement that are frequently so marked as to challenge attention. Most conspicuous, however, though something that was entirely unlooked for, was the effect observed on the muscular strength of the various subjects.

"With the soldier detail, fifteen distinct strength tests were made with each man during the six months' period by means of appropriate dynamometer tests. . . . Without exception, with all of the men a phenomenal gain in strength was noted, which demands explanation. Was it all due to the change in diet? Probably not, for these men at the beginning of the experiment were untrained, and it is not to be assumed that months of practical work in the gymnasium would not result in a certain amount of physical development with corresponding gain in muscular skill and power. Putting the question aside for the moment, however, it is surely proper to emphasize this fact, viz., that although the men for a period of five months were restricted to a daily diet containing only one-third to one-half the amount of protein food they had been accustomed to, there was no loss of physical strength, no indication of any physical deterioration that could be detected. In other words, the men were certainly not being weakened by the lowered intake of protein food. This is in harmony with the principle already discussed, that the energy of muscle work comes primarily from the breaking down of non-nitrogenous material, and consequently a diminished intake of protein food can have no inhibitory effect, provided of course there is an adequate amount of proteid ingested to satisfy the endogenous requirements of the tissues."

It is now a fairly well established fact that the average need for proteid food by adults is fully met by a supply from five to six grains for each pound of body-weight. Hence, for a man weighing 150 pounds there would be required about two ounces of protein daily. Some German dietitians have reduced even this amount to one-half and advocate a nutritive ratio of 1:20 (proportion of protein to fats and carbohydrates). *It should be remembered, however, that such low standards can be maintained only when due respect is paid to the quality of the food, particularly to its content of organic salts, a matter which has been entirely overlooked by nearly all investigators along these lines.*

For instance, Dr. Chittenden outlines a daily dietary in which sweets and farinaceous foods predominate, while there is deficiency of fresh fruits and well prepared vegetables, which supply the needful organic salts for the formation of normal and healthy blood, a fact which will be better understood by a careful study of the following chapters. Such a diet may not show any ill effects in the course of a few months or a year, especially if the person takes a liberal amount of exercise and does not take stimulants and narcotics. But it may be safely said that in time grave functional disorders will appear if the elements which are essential for the formation of normal and healthy blood are not furnished in sufficient quantity and in the right proportion. It often takes nearly a lifetime to ascertain the merits and demerits of a certain dietetic regimen. There are many persons who are apparently healthy, but are suddenly "stricken" with disease.

While the menus outlined by Dr. Chittenden are better than the average American dietary, still they leave room for improvement. If the organic salts are not furnished in the right proportion, or if any of the elements are lacking in our daily food, which may be otherwise well-proportioned, the living cells of the body are broken down in abnormal quantities in order to make up for the deficiency. *Nevertheless, the medical profession still holds to the idea that a high protein diet is necessary. Doctors are not yet realizing the great importance of the organic salts for the human body, for the performance of its various physiological functions and their relation to health and disease.*

While some dietitians admit that the body can maintain itself for a short period on a small amount of protein, they claim

that finally the organism will be injured if the usual quantity of nitrogenous foods is not supplied. This theory is pretty well refuted by the investigations of the Japanese scientist, Kintaro Oshima, who published an interesting treatise in the English language giving the results of a number of experiments among all classes of people living in different parts of Japan where certain dietetic habits have been established for hundreds of years. Says Oshima:

"Probably the most interesting of the dietary studies are those with poorer classes which comprise by far the larger part of the population. The dietaries of the miscellaneous class, including employees, prisoners, etc., consisted largely of vegetable foods and supplied on an average 59 grains (2 ounces of proteid and 2190 calories of energy) per man per day."

Most instructive and interesting are the results obtained in a study of the dietary habits of three healthy natives of Formosa, employed as day laborers at the military hospital. They weighed respectively 134, 121, 120½ pounds. The main portion of their diet was rice, supplemented by a little salt fish, melon, spinach, ginger and greens. The daily amount of protein consumed was 48 grams or about 37 grams (1⅓ ounces) digestible protein, with a total fuel value of 1948 calories. We may assume that the amount of protein in the dietaries of the classes living largely on vegetable foods may not be very far from 2 ounces or 1½ ounces digestible protein.

Oshima gives a significant picture of the Japanese farming districts:

"The rural population of the interior depends very largely or entirely upon a vegetable diet. Fish is eaten perhaps once or twice a month and meat once or twice a year, if at all. The poorer working classes in the cities also use very little animal food. But the poorer classes in the city and the peasantry comprise nearly 75% of the total population, and it is, therefore, safe to assume that this proportion lives chiefly or wholly upon vegetable diet. And this, it may be observed, practically means vegetarianism. The so-called lacto-vegetarianism is unknown in Japan. Cows are scarce, and milk and other dairy products are expensive, and such as are available are consumed almost entirely by the wealthier people in the cities."

In regard to the sanitary conditions Oshima remarks that *the peasants in the rural districts of Japan are really healthier and stronger than people of the better classes who live on a mixed diet.*

Regarding the disease known as beri-beri, which frequently occurred, especially in the Japanese navy, Oshima says: "While no satisfactory explanation as to the cause of disease was offered, it was generally believed that there was some very close relation between the disease and the rice-diet." Baron Takaki, the Japanese Surgeon-General, claims that the disease is due to a lack of nitrogen in the food supply, but there is a more correct explanation of the cause of this dreaded nervous disease. The Japanese remove the outer coat from the rice-kernel and with it some important organic salts, especially potash, magnesia, oxide of iron, fluoride of calcium and silica. Fish is also deficient in iron and silica, and when at the same time not a sufficient quantity of fresh vegetables is supplied, the blood is impoverished and the nerves starved. In combating the disease, a liberal supply of vegetables which are rich in soda, iron, silica and chlorine, is far more effective than an increase of nitrogenous food in the form of canned meats which were imported in large quantities during the recent war. From the official reports it appears that, in considering the dietetic requirements of man, too much attention has been paid to the proteins, and not enough to the proportion of the organic salts.

The experiments of the German scientist Rubner demonstrated that *only four per cent of the entire production of energy in the system goes to the renewal of the tissues, and only four per cent have to be supplied by the proteins of our food.* In a total production of about 2,800 calories per day, this would amount to about 112 calories, equal to about one ounce of protein, or four times less than the requirements of the old formulas of Voit and Atwater. The low protein requirements of man's normal diet are distinctly proven by the changes which occur in mother's milk, at the different stages of the child's development; these changes are illustrated in the following table, giving the analyses taken at different periods:

TIME AFTER BIRTH	Protein Per Cent	Fat Per Cent	Milk Sugar Per Cent
From the 8th to the 11th day	2.38	2.92	6.39
From the 20th to the 40th day	1.79	4.04	6.36
From the 70th to the 120th day	1.49	3.29	6.66
At the 170th and later	1.07	2.47	6.86

The mammary glands of the mother supply less protein as the nursing child grows older, so that after six months the percentage

of protein has decreased about seventy per cent, and *at the end of the nursing period the ratio of protein to non-nitrogenous compounds may be considered as one to twelve.*

Another important fact regarding nutrition is that the milk of the various mammals has different amounts of protein adapted to the rapidity of the growth of the organism. Bunge shows this in the following comparative table:

	Time in days for the new-born animal to double its weight	100 parts of milk contain protein	
Man	180	1.6	(average)
Horse	60	2.0	"
Calf	47	3.5	"
Kid	19	4.3	"
Pig	18	5.9	"
Lamb	10	6.5	"
Dog	8	7.1	"
Cat	7	9.5	"

It appears that the rapidly growing body of the infant is well nourished with milk containing less than two per cent protein, or about one-half an ounce of protein per day, figuring four pints of milk as a liberal daily supply.

These are certainly excellent proofs that our daily requirement of protein is much smaller than has been so far assumed. The necessary amount of from one to about two ounces per day for the adult man can easily be supplied by the products of the vegetable kingdom without unduly taxing the digestive organs. The craving for concentrated protein foods, like meat, is one of man's acquired habits which lead to many diseased conditions. A diet of fresh fruits and green-leaf vegetables, supplemented by a small amount of nuts (preferably nut butter, hygienically prepared), or dairy products, furnishes sufficient protein for almost any emergency, and such a diet is at the same time most conducive to health and longevity.

CHAPTER VII

FATS

The non-nitrogenous constituents of foods are divided into two distinct groups: fats and carbohydrates. Both groups are made up of the same three elements—carbon, hydrogen and oxygen—but the quantitative composition is quite different.

Fats are much poorer in oxygen and richer in carbon and hydrogen than carbohydrates, while their heat equivalent is much greater. They yield 4040 calories per pound, while carbohydrates furnish only 1820 calories per pound. The fats are made up of about 76 per cent carbon, 12 per cent hydrogen and 12 per cent oxygen.

Fats, as previously stated, exist chiefly in the seeds of plants and to some extent in fruits, leaves and stems, also in animal foods, such as milk, eggs and meat. In the animal body fat is mostly deposited near the surface, but it is also scattered in minute particles through the various tissues. Fats form on an average about fifteen per cent of the weight of the body, but the amount varies with the quantity and quality of food, exercise, climatic and other conditions. When more food is taken than is necessary for immediate use, the surplus is usually stored up as fat in the body. Lack of certain organic salts, like iron and sodium, in food also favors the formation of fat, since the blood is unable to take up a sufficient amount of oxygen for the complete combustion of the carbon. Under these conditions, both protein and carbohydrates are converted into adipose tissue.

The fats found in plants are, like the carbohydrates, derived from carbon dioxide and water, and are also very likely formed synthetically through the agency of chlorophyl. The fat in the animal body may have three different sources. One portion may be derived from the fats which have been ingested as food; another may be formed from the different carbohydrates; while a third may be the product of the decomposition of protein. That portion of the body's fat which is directly derived from the ingested fats is comparatively small, the greater amount resulting from the carbohydrates.

The principal fats contained in vegetable and animal food products are olein, palmitin and stearin. These are chemical combinations of glycerin ($C_3H_8O_3$) and fatty acids; the former being a common constituent, while each fat shows its own characteristic acid. Accordingly we find:

Oleic acid ($C_{18}H_{34}O_2$) in olein
Palmitic acid ($C_{16}H_{32}O_2$) in palmitin
Stearic acid ($C_{18}H_{36}O_2$) in stearin

In round numbers it may be said that fats are composed of nine parts of a fatty acid and one part of glycerine. When at a moderate temperature these combinations are in a liquid form they are called oil. If in a solid or semi-solid condition, they are known as fats.

The three above mentioned fatty acids are the most important from a dietetic point of view, as they make up the greater part of the edible vegetable oils and fats. Of the three, oleic acid constitutes the greatest part of nearly all fats, especially oil. Palmitic acid exists chiefly in certain forms of vegetable oil and fats, while stearic acid is a constituent of animal oils and fats.

The hydrogenation of fats and oils, a process recently discovered, is now widely used for hardening fats. The process consists of heating them to a temperature of from 212° F. to 400° F., and introducing hydrogen in connection with some catalyctic agent, such as nickel or platinum. By means of this process the oleic acid molecule takes up two atoms of hydrogen and is turned into stearic acid. After completing the process the metal is removed by filtration. The heating of the oils destroys the natural flavor and the vitamins. Cottonseed oil, peanut oil and corn oil are generally hydrogenated, while the oils of olives and nuts are not, as a rule, subjected to this process, and therefore are preferable.

In nearly all fats there is found also a small quantity of free acid, that is, a fatty acid which is uncombined with the glycerine. This free acid is contained in larger proportions in over-ripe and older plants than in the freshly matured ones. The extracted oil also contains certain other ingredients or impurities, which have to be removed by the process of refining before they are ready for the table. Among the free fatty acids may be mentioned linolin acid, which exists in considerable quantities in the oil of flaxseed, giving to it the property of a drying oil which makes it useful in

the manufacture of paints. All oils and fats which contain appreciable quantities of linolin, or any other fatty acid which has drying properties, are not fit for nutrition. The principal drying oils are linseed oil, hempseed oil, and poppy seed oil. Small quantities of free acids are found in cottonseed oil, sesame oil, maize or corn oil, and rapeseed oil. Olive oil and peanut oil are the best oils from a hygienic point of view.

One of the vegetable oils which contains particularly injurious substances is castor oil. The poisonous and purgative effects are due to a substance called *ricinolein.* The castor bean from which the oil is obtained, contains also a poisonous alkaloid called *ricin,* particles of which are mingled with the oil itself.

All fats have a lower specific gravity than water, usually ranging from 0.89 to 0.94.

Essential or *volatile oils* which are mostly used for flavoring purposes, differ from fats or fixed oils in chemical composition and physical properties. They are readily volatilized, leaving no residue, while the fixed fats are practically non-volatile. The characteristic flavor of many fruits and vegetables is due to the essential oils they contain. These oils have little food value, but often promote favorable digestive action and increase the palatability of the food.

Closely related to the fats are the different *lecithins* and *cholesterins.* The lecithins are compounds which may be regarded as a union of one molecule of glycerine with two molecules of a fatty acid, one molecule of phosphoric acid and one molecule of cholin, with the loss of four molecules of water. Cholin has an ammonium base, the composition of which is indicated by the chemical formula $C_5O_2H_{14}N$. The lecithins are widely distributed in both the animal and vegetable worlds. They are found in all cells and body fluids and are especially abundant in nerve-tissue, as well as in the eggs, in the ovum and semen of animals and man. In common with fats, to which they are very similar in composition, lecithins have the property of solubility in alcohol and ether, but at the same time they possess the peculiar power of swelling and becoming slimy in water. This property enables them to aid in the interaction of watery solutions and substances not soluble in water, and also to take part in a large variety of chemi-

cal processes of the body. The presence of lecithin in milk shows how indispensable this substance is in nutrition of the infant.

The cholesterins, like the lecithins, are normal constituents of all vegetable and animal tissues, as well as of milk. They are especially abundant in the nerve tissue and in bile. Like lecithins and fats, they are insoluble in water, but soluble in ether and alcohol. The chemical composition of cholesterin is represented by the formula $C_{27}H_{46}O$.

In natural food products the fats are mingled with other substances. Free fats, such as oils (extracted from oily seeds or fruits) and butter, are highly concentrated food principles and should be used sparingly and not without some less concentrated foods, such as green-leaf vegetables, which are rich in alkaline bases. In order to be digested, fats must be saponified, i. e., split up in the intestine into glycerine and salts of fatty acids. The presence of free alkalies, especially sodium salts, is necessary for this process of saponification and these are furnished by the bile and pancreatic juice. The fatty acids, after saponification, are absorbed and reconstructed into neutral fats. Fats derived from the vegetable kingdom should always be preferred to those derived from dead animals. The following table gives the percentage of fat in various food products:

Amount of Fat in Food Materials

ANIMAL PRODUCTS

White of eggs	0.25	per cent	Yolk of egg	32.	per cent
Buttermilk	0.50	" "	Swiss cheese	35.	" "
Cottage cheese	1.	" "	Salt pork	60.	" "
Cow's milk	3.70	" "	Bacon, smoked	62.	" "
Human milk	4.	" "	Oleomargarine	83.	" "
Meat, average	5.	" "	Cow's butter	85.	" "
Eggs, whole	12.	" "	Lard, unrefined	94.	" "
Cream	18.50	" "			

VEGETABLES AND FRUITS

Vegetables	0.10 to 1.	per cent	Sunflower seed	32.	per cent
			Poppy seed	38.	" "
Sweet fruits	0.50 to 1.	" "	Cocoa beans	50.	" "
Legumes	1. to 2.	" "	Olive (dried)	52.	" "
Avocado	20.	" "	Refined oils	100.	" "
Mustard seed	30.	" "			

Amount of Fat in Food Materials—Continued

CEREALS

Polished rice	0.50	per cent	Barley	2.20	per cent
Unpolished rice	0.90	" "	Wheat bran	3.50	" "
White flour	0.90	" "	Rye bran	3.70	" "
Corn flour	1.30	" "	Millet	3.80	" "
Whole rye	1.80	" "	Corn	4.60	" "
Whole wheat	1.90	" "	Oats	5.20	" "
			Rice bran	7.80	" "

NUTS

Chestnuts, dry	7.	per cent	Pistachios	55.	per cent
Cocoanuts	36.	" "	Pinons	62.	" "
Beechnuts	42.50	" "	Filberts	64.	" "
Peanuts	45.	" "	Walnuts	65.	" "
Pignolias	48.	" "	Brazil nuts	65.	" "
Almonds	55.	" "	Pecans	70.	" "

CHAPTER VIII

Carbohydrates

Carbohydrates comprise a number of chemically related substances: the sugars of different kinds; the various forms of starch in its normal condition, as well as in soluble form, such as dextrins, etc.; the gums, pectins, or jelly-like bodies; and finally fiber and cellulose. They contain on an average 44 per cent carbon, 6 per cent hydrogen, 50 per cent oxygen.

They are subdivided according to their chemical composition into three distinct groups:

1. *Monosaccharides* ($C_6H_{12}O_6$), comprising *grape sugar* (dextrose or glucose), *fruit sugar* (fructose or levulose) and *galatose* (derived from milk sugar).

2. *Disaccharides* ($C_{12}H_{22}O_{11}$), comprising *sucrose* (saccharose or cane sugar) found often combined with dextrose and fructose in the juice of many fruits and vegetables, *maltose* (malt sugar) formed from starch by enzymic action, and *lactose* (milk sugar) found in the milk of all mammals.

3. *Polysaccharides* ($C_6H_{10}O_5$) X; "X" being a variable factor, but always exceeding 2. They include *starch,* in which form nature stores most of the carbohydrates in the vegetable kingdom; *glycogen,* which is stored as reserve carbohydrate principally in the liver and muscular tissues of the animals; *dextrins,* which are formed from starch by diastase, acid or heat; *cellulose,* principally found in wood and in the cell walls of plants; *galactans,* which occur in seeds of legumes and cereals, in some of the algæ and lichens, and the *pectins* or jelly-like bodies. To this group also belong the *pentosans* ($C_5H_8O_4$) X, which generally exist in the fibrous tissues and gummy exudations of plants, but not in the starchy and succulent parts.

By the chemical addition of a certain amount of water the second and third groups can be converted into substances of the first. This process is called *inversion* and may be produced in a number of ways.

Grape-sugar and fruit-sugar exist together in most of the sweet

fruits and honey, and, although they have the same chemical composition, they are not identical bodies. This is accounted for by their peculiar molecular structure, the same number of atoms being arranged in a different way.

Cane sugar (sucrose), or the more or less refined sugar of commerce, is two and one-half times sweeter than grape sugar. It exists in many vegetable juices. It is found in the stems and roots of all the grasses, especially in the sugar cane and sorghum; in succulent roots, such as the carrot, turnip, sweet potato and sugar beet; in the sap of trees, such as the date palm and sugar maple; also to a small extent in all sweet fruits, and in the nectar of flowers. The commercial manufacture of refined sugar from sugar beets and sugar cane has developed from crude beginnings. In ancient times sugar was a very expensive luxury, mostly imported from the Orient. In the latter part of the nineteenth century the manufacture of refined sugar from sugar cane and sugar beets developed to such an extent, both in America and in Europe, that it is now one of the great staples of commerce.

Cane sugar cannot be directly utilized in the body. By the action of a ferment in the intestine known as *invertin* it is converted into monosaccharides, that is, changed into levulose and glucose which are ready for immediate absorption and use in the system. The change of cane sugar in solution into dextrose and levulose can also be brought about to some extent by the action of heat and diluted acids, as in cooking fruits with cane sugar.

Maltose, belonging to the same group of disaccharides, is produced in sprouting grains by a digestive process which converts the starch into sugar. The unorganized ferment, or enzyme, which accomplishes this change is known as *diastase*. A similar ferment is found in the saliva, as well as in the pancreatic juice. This ferment is able to convert raw starch into maltose, which may be absorbed without undergoing change in the intestine.

It should be borne in mind, however, that the various forms of sugar, as we find them in their natural state in fruits, stems and roots, are organized by nature during the process of growth, and intimately associated with other nourishing constituents. Sugars contained in natural food products are infinitely better than the manufactured sweets of commerce, which are chemically isolated food principles and can never fully supply the needs of the body.

The reason for the injurious effects of manufactured sugar and glucose is that they are artificially extracted and separated from those organic combinations which are necessary for the building up of tissues and bones, for the proper functioning of the nervous system and the purification of the blood. Without a constant renewal of the elements of iron and sodium the blood cannot take up sufficient oxygen and the products of combustion cannot be neutralized and eliminated. The blood stream is overloaded with waste products, causing sluggishness and general drowsiness, the symptoms of carbonic acid poisoning.

The extensive use of artificial sweets, especially in connection with starch foods is responsible for a large number of diseases of the digestive organs. The liver and kidneys are severely affected by the increased formation of toxic substances, and the accumulation of acids in the blood causes a catarrhal condition of all the mucous membranes. Not enough can be said in warning against the prevalent and extensive use of refined sugar in the various forms of pastry and confectionery. That the general public is not aware of the injurious effects of artificial sweets, seems to be indicated by the rapid increase in the manufacture and consumption of sugar.

Figures gathered by the Bureau of Statistics show that the average American consumes about ninety pounds of sugar every year, and Uncle Sam's sugar bill averages over two million dollars a day. The total annual consumption of sugar in the United States amounts to about ten billion pounds. Calculating this enormous total at the average retail price of 7½ cents per pound, we get a total of $750,000,000 as its cost to the consumers.

The per capita consumption of sugar in the principal countries is as follows:

Australia	112.96	pounds
England	95.70	"
Canada	92.70	"
Argentine Republic	64.10	"
Germany	40.92	"
France	36.05	"
Austria	24.32	"
Russia	20.55	"
Spain	11.37	"
Italy	7.63	"
Europe	31.61	"

The foregoing table shows that the United States consumed more sugar per capita than any other countries except Australia and England, the consumption in this country being nearly three times as much as in European countries in general. Whatever interest these figures may possess from a commercial standpoint, considered from a hygienic point of view, they are deplorable. Indeed, the use of artificial sweets is one of the most pernicious customs of the day, causing defective development of the skeleton of the infantile body, and in later years a morbid softening of the bones, making dentistry one of the most lucrative professions in this country.

The taste for sweets is natural, and indicates a physiological demand. This demand, however, can be met only by the natural sweets existing principally in sweet fruits. The nutritious and fattening qualities of the whole sugar cane, for instance, are sufficiently shown on every sugar estate. The negroes of the West Indies and animals about the plantation at the time of harvest show conclusively, by the excellent state of their health, the wholesome and nutritious properties of the cane juice. This is but another illustration of the fact that we cannot improve on nature; for in the ripened sugar cane sugar is organized with other constituents, making it a complete food.

Some of the sugar that is not immediately needed by the system is converted by the liver into glycogen, and stored away in that organ and in the muscles for future use in the performance of muscular work. The habitual indulgence in sugar in the concentrated form, causes fatty degeneration of the organs of the body. This condition is known to be the foundation of such disorders as diabetes, apoplexy, paralysis, fatty heart and abnormal conditions of the liver, kidneys, muscles and bones. Again, sugar in great excess of what the liver can take care of, causes fermentation in the alimentary canal, producing alcohol, carbonic and acetic acids. Like all other acquired tastes, the sugar eating habit is hard to give up, but numerous tests have shown that when the habit is once broken, the natural taste of food appears more pleasant than when it is disguised by the presence of manufactured sugar.

Milk sugar, or lactose, is similar in chemical composition to cane sugar, but is not nearly so sweet. It is found in the milk of all mammals in various percentages, ranging from two to eight per cent. It is the most digestible sugar for infants. When milk is

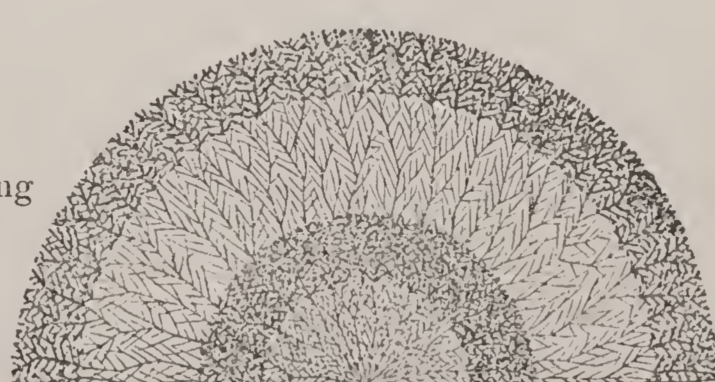
exposed to the air, the milk sugar undergoes decomposition whereby lactic acid is formed and the milk becomes sour. In fermentation one molecule of milk sugar takes up one of water and splits into four of lactic acid. ($C_{12}H_{22}O_{11}$ plus H_2O equals $4C_3H_6O_3$.)

Starch, next to water, is the substance most abundant in the average diet of man, largely because the majority of the food products which contain it can be produced cheaply. In nature starches are never found in their proximate form—they are always intimately connected with other food-elements of the protoplasmic cell.

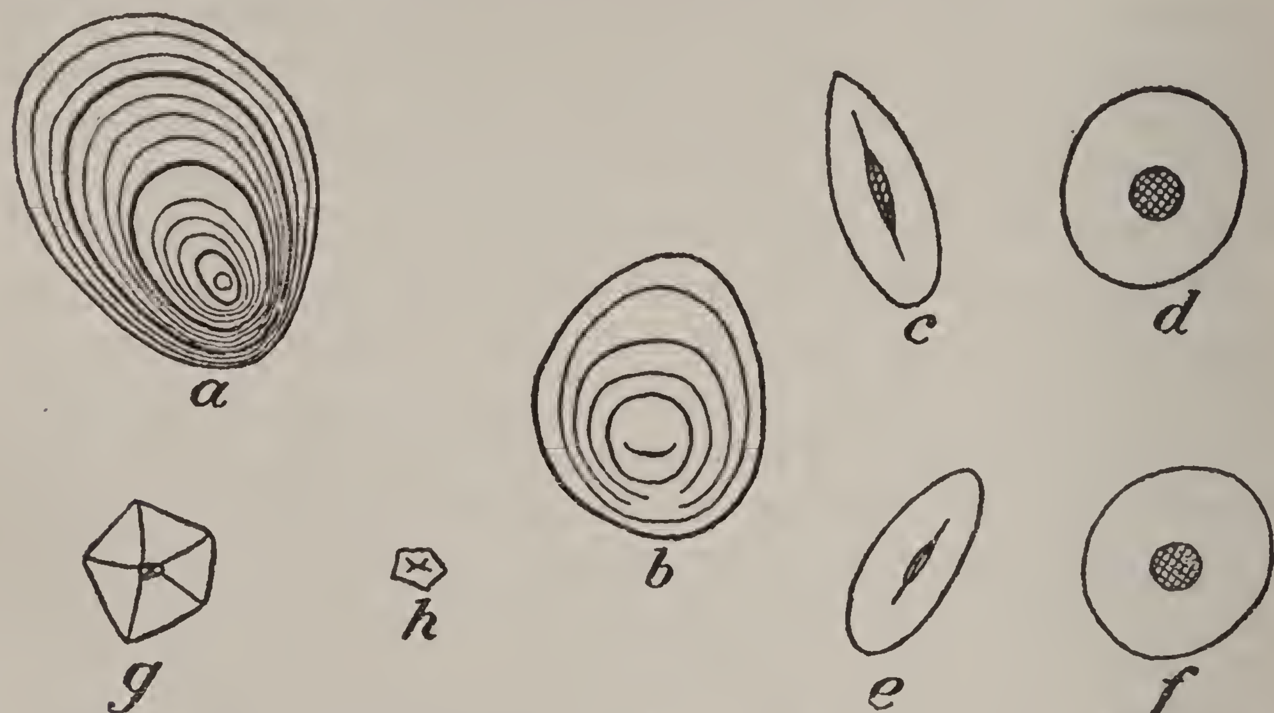
The general formula for starches and dextrins, or polysaccharides, is $(C_6H_{10}O_5)$ X, in which "X" is a variable factor, but always exceeds two. In the case of the starch molecule X is equivalent to 108; in others, such as glycogen and dextrins, X is much smaller. Starch is the form in which nature stores up the carbohydrates in seeds and roots for future use. If sugar were stored away in the place of starch it would be dissolved by the first rainstorm, and the water would spoil the seed; but raw starch is insoluble and at the same time unfermentable. For instance, there is but little starch in corn until it is perfectly ripe; then the soluble dextrine and sugar are converted into starch and deposited in the kernel for future use. If green corn is eaten we get the starch mostly in soluble form, but, as the kernels mature, the dextrin and sugar are finally converted into starch, leaving to remain only a small quantity of sucrose. The same is true of all the cereals.

Raw starch grains from different kinds of plants vary in their microscopic appearance, and it is interesting to study their peculiar structure. Arthur Meyer, a German scientist, made a series of investigations of starch grains, and as a result of his work he offers a theory of starch composition which is generally accepted by the botanists today. Starch grains are more or less regular spheres, composed of a mass of radiating needle-shaped crystals, which he calls "trichites."

Four-layered Starch Grain, according to Professor Meyer



The diagram on page 71, taken from Professor Meyer's "Investigations of Starch Granules," illustrates his theory of a four-layered starch grain, while the illustration following gives the appearance of raw starch grains, magnified 385 times.



Starch grains: *a*, from potato; *b*, from arrowroot; *c* and *d*, from wheat; *c* side view, *d* flat view; *e* and *f* from barley; *g*, from corn (maize); *h*, from rice. (Courtesy of U. S. Dept. of Agriculture.)

First we note the characteristic appearance of a normal potato starch grain, showing on an average of twenty layers. According to Professor Meyer these layers are composed of trichites and are successively deposited one outside of another, beginning with the point of origin. The difference in the appearance of the layers of the various starches is due to the changing size of the trichites and to the smaller or larger amount of space between them. This, again, is due to alternating changes in growth conditions in the plant cell under which the grain is formed, the loose layers being produced, during the night, by partial solution on the surface of the starch deposited during the previous day. The outer layer is not different from the others except that in some cases it is more dense, due to the fact that the starch is gathered after the end of the growth period in the plant, and the last growth is slower than the first.

The starches of all grains are similarly constructed, although they present different appearances. The potato and arrowroot starch grains are irregularly ovoid solid grains, while the wheat and barley starch grains are lens-shaped, showing a hollowed space

in the center. Rice and cornstarch grains are generally polyhedral in shape, with a more or less star-shaped crack in the center. The starch grains are of various sizes, and there are several hundred in a single cell, and from 10,000,000 to 20,000,000 in a kernel of wheat. The flour cells, which are found in the interior portion of the wheat kernel, in addition to starch, contain gluten and a small proportion of fat and mineral matter; they do not consist of starch only, as appears from the following illustration:

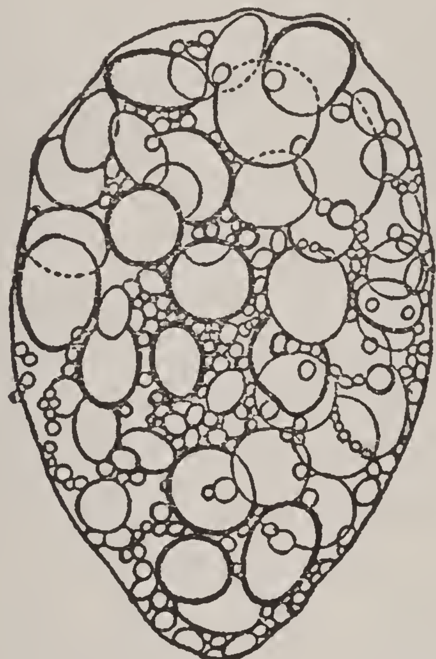


FIG. 1. Starch grains in a flour cell of the wheat berry

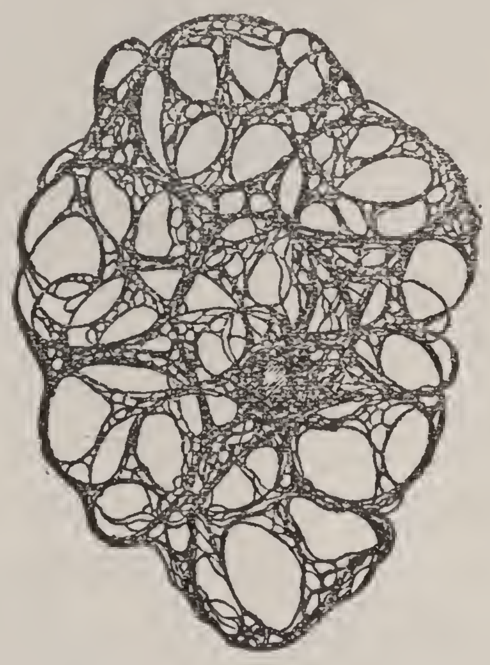


FIG. 2. Protoplasmic structure of a flour cell with its nucleus

(Courtesy U. S. Dept. of Agriculture.)

In order to make clear the complicated structure of a single flour cell, we should remember that starch grains (Fig. 1) are embedded in the protoplasmic network (Fig. 2). The character of the cell contents varies considerably in different parts of the wheat berry. The interior portions show proportionately more starch than the outer layers of the kernel, which are richer in gluten and mineral elements.

We have learned that nature changes sugar and dextrine in the ripening grain into insoluble starch, and the protoplasmic flour cell contains the food with which the little plant has to start out in life in the succeeding generation. But the embryo plant, which again proceeds from the germ, cannot make any use of raw starch; so nature deposits in each kernel of grain, like wheat, corn, barley, or rye, a little digestive agent, called *diastase,* which has the power of converting the starch into soluble form, as soon as the sun,

moisture and warmth begin their action on the soil. Thus the food is made digestible for the embryo plant, furnishing it with material for building up a stem with its two rudimentary leaves, the plant being nourished in this manner until it grows well above the ground, for only under the vitalizing influence of the direct sunlight is starch formed in the chlorophyll grains by the chemical combination of carbon dioxide and water.

Sachs, another German scientist, has clearly shown by a series of experiments, that as soon as the breaking up of the carbonic acid ceases, during the night, the formation of starch also ceases. As starch, in addition to carbon, contains only hydrogen and oxygen in the same relative proportion as water, it can be derived by synthesis from the carbon that is set free and the water that is received through the roots. In starch we have the first and sole visible product of assimilation, from which all other organic compounds of the plant are derived, by means of chemical combination with other elements. If, therefore, the plant forms later other carbohydrates, fats, and finally proteids, all of which contain carbon, it can only employ starch as a starting point. It is the plant which originally constructs the highly complex protein molecule out of the simplest inorganic compounds, carbon dioxide, water, salts and ammonia. Man and all animals are directly or indirectly dependent on the vegetable kingdom for their food.

As already stated, the raw starch is converted into soluble forms of carbohydrates, by the action of diastase which belongs to the unorganized but soluble ferments called "enzymes." These ferments have a cell structure like the organized ferments, and are composed of carbon, hydrogen, nitrogen, oxygen, and mineral matter. Diastase coagulates in a watery solution on being heated to 167° F. When dry it withstands a temperature of 310° F. Its action upon starch is increased by the presence of minimum amounts of acids, as well as small amounts of salts. Greater amounts of acids and alkalies hinder or completely check its action. Under favorable conditions diastase is able to convert large amounts of starch into soluble compounds. When starch is exposed to the action of diastase, it undergoes a series of successive decompositions, resulting finally in maltose. All of these intermediate products are soluble in water, and hence more easily assimilated and digested than the natural starch grain.

The enzymes are found principally in cereal grains, and it appears that each species possesses a specific enzyme, but so far the enzyme of barley, or diastase, has served as the type for this kind of ferments. Certain bacteria act upon solid or liquefied starch in a manner similar to diastase, and the action is probably due to an enzyme secreted by the bacteria. The yeast employed for raising bread contains also a specific enzyme, capable of inverting many times its own weight of starch and producing the fermentable dextrose. All these enzymes become active during the process of germination, and as moisture is the exciting cause of this activity, it follows that, whenever raw grain or the flour prepared from it is moistened, as in the preparation of bread, conditions are produced for the action of the diastase upon starch. The action of the enzymes, however, is checked as soon as the baking begins, as they are rendered ineffective by a temperature exceeding 167° F.

During exposure to heat and moisture the starch cells are also affected in a mechanical way, and the following illustration shows how the starch cells of the potato are changed in cooking.

Changes of starch cells in cooking: *a*, cells of a raw potato with starch grains in natural condition; *b*, cells of a partially cooked potato; *c*, cells of a thoroughly boiled potato. (Courtesy of U. S. Dept. of Agriculture.)

The expanding steam breaks the minute cell walls and the starch grains inside the cells are thus released; some of them being also disintegrated, while part of them are changed into the soluble form of dextrine. When suspended in water, all varieties of starch are converted in soluble forms at a temperature of 212° F. or less. In order to cook starch it is essential that every grain be brought into contact with water of at least 140° to 178° F. The action becomes less marked where the starch is merely moist. Dry starch is converted into soluble forms at about 400° F., the temperature

of the bake oven. According to these views the starch of bread should be made largely soluble by baking, but only a small amount of soluble starch, dextrine, etc., is produced in the crust of the loaf. The starch of the interior is hardly heated beyond 212° F., and this is not sufficient in the absence of an excess of moisture to produce the change to soluble forms.

Contrary to generally accepted belief, the process of baking does not change the nature or condition of the carbohydrates in cereals to any appreciable extent, as it is shown in the following table compiled by the U. S. Department of Agriculture:

Carbohydrates in Dry Matter of Wheat, Maize and Bread

	Whole Winter Wheat		Fine Flour Winter Wheat		Maize	
	Raw Grain Per Cent	Bread Per Cent	Raw Flour Per Cent	Bread Per Cent	Raw Grain Per Cent	Bread Per Ct.
Sucrose	0.51	0.014	0.20	0.15	0.27	0.16
Invert sugar	0.08	0.10	None	0.38	None	0.19
Dextrin	0.27	0.68	1.06	0.91	0.32	None
Soluble starch	None	1.37	None	1.74	None	2.80
Normal starch	30.94	27.93	34.04	31.99	42.50	40.37
Pentosans	4.54	4.16	None	None	5.14	3.54
Crude fiber	2.68	2.70	0.25	0.17	1.99	2.22
Total	39.02	36.96	35.55	35.34	50.22	49.28

When the grains, or the flours made from them, are subjected to the action of yeast and heat, as in baking bread, an absolute loss of carbohydrates occurs, amounting to from one to five per cent of the total dry matter of the flour or grain.

The combined action of moisture, yeast and heat in preparing and baking bread, diminishes the sugar and tends to convert the starch into soluble and fermentable forms. The actual amount of starch thus changed does not exceed ten per cent of the total starch present. This change occurs in the more exposed portions of the loaf. In the interior the starch undergoes practically no change. In other words, in the ordinary loaf of bread ninety per cent of the starch is in an unsoluble state. In toasting the bread some of the starch is dextrinized, but at the same time, the other ingredients, the protein and organic salts, are still further impaired. From all these facts it appears that cereals and starchy foods are by no means an ideal food for man, as is so often claimed. Cereals are useful to the extent that they provide carbohydrates in absence of sweet and dried fruits.

Nature never intended that we should eat products of the soil containing a large amount of raw starch, as our teeth are not suitably constructed for the perfect mastication of dry grain. As will be shown in one of the following chapters, man's original home was in the tropical and subtropical zones which produce an abundance of fruits containing the carbohydrates in a soluble form and needing no further preparation. Persons with sound teeth and healthy digestive organs can undoubtedly eat raw cereals in reasonable amounts with impunity, but it is difficult to break down all the cell walls protecting the starch grains, even by prolonged mastication. Only a small percentage of the starch is changed by the enzyme of the saliva; and while the inversion, if there is no hyperacidity, may go on for some time in the stomach, it has to be completed by the more powerful enzyme of the pancreatic juice.

One of the advantages in cooking or baking potatoes and other starchy foods is the improvement in flavor, which is due in part to the development of the cooked-starch taste, which is more pleasant than that of raw starch. The degree of digestibility of the most used starches, beginning with the starch which is most easily digested, is as follows: potato, sweet potato, corn, rice, and wheat. Cereal products should preferably be eaten in a dry state to ensure perfect mastication. Mixtures of watery mushes and concentrated cane sugar should be avoided, as they are apt to cause fermentations, because the presence of sugar interferes with the digestion of starch.

Cellulose, which also belongs to the class of carbohydrates, is the basis of the cell structure of plants and exists in various forms. It is sometimes a hard and dense substance, but in the earlier stages of plant growth, as in tender leaves and vegetables, it is chemically combined with water in a more soluble and digestible form. Until quite recently cellulose was held to be indigestible, but experiments have proven that a large percentage may disappear in the digestive canal; and if the foods are thoroughly masticated, from twenty-five to fifty per cent are digested. While, on an average, cellulose may have but little food value, it is of great importance in acting as a mechanical stimulus to promote the peristaltic movement of the intestine. The diet of man must contain some bulk in the form of more or less woody fibres, as the muscular wall of the

intestine, if it has no work to do, becomes atrophied like every other muscle.

There is a tendency among the American people to remove as much as possible of the cellulose from food and to give a preference to artificially prepared and concentrated food products, a circumstance which has led to an almost universal debility of the intestinal muscular walls, with resultant chronic constipation. For the same reason an exclusive milk diet will lead to costiveness, because animal foods and products contain no cellulose. The following table gives the amount of cellulose in a number of foods used by man:

Food Products	Per Cent Cellulose	Food Products	Per Cent Cellulose
Rice flour	0.2	Peanuts	2.2
Wheat flour (fine)	0.3	Strawberries	2.3
Rice, polished	0.6	Maize	2.5
Cucumber	0.6	Whole wheat	2.5
Onion	0.7	Peas	2.6
Potato	0.8	Horseradish	2.8
Tomato	0.8	Lentils	3.0
Cauliflower	0.9	Filberts	3.3
Oatmeal	1.0	Beans	3.6
Asparagus	1.0	Grapes	3.6
Carrots	1.0	Rice, unpolished	4.0
Melon	1.1	Pears	4.3
String beans	1.2	Plums	4.3
Mushroom	1.4	Figs	4.5
Apple	1.5	Whole barley	5.3
Rye meal	1.6	Prunes	5.4
Radish	1.6	Dates	5.5
Barley, peeled	1.6	Walnuts	6.2
Cabbage	1.8	Almonds	6.6
Oranges, peeled	1.8	Raspberries	6.7
Green peas	1.9	Wheat bran	8.7
Rye	2.0	Rice bran	10.6

The *pectins* are jelly-like bodies, which are closely related to the carbohydrates and are contained in most fruits and vegetables. In the early stages of growth the pectins are combined with organic acids, forming insoluble compounds, but during the ripening of fruit and cooking of vegetables they are changed into soluble compounds, which in nutrition serve practically the same functions as starches and sugars. In food analyses the pectin bodies are usually included with the carbohydrates.

CHAPTER IX

Organic Acids

Organic acids in foods should be distinguished from the acids of decomposition such as uric acid, etc. Organic acids are used by the living plants in their synthetic processes. In the ripening of fruit some of the acids are progressively utilized in the formation of ethers and carbohydrates. Others are combined to form salts of potassium, sodium, calcium, magnesium, etc. The combined organic acids or salts consumed in food are generally changed in the animal body into alkaline carbonates, thereby increasing the alkalinity of the blood and secretions. The uncombined acids either form alkaline carbonates, or are oxidized into carbon dioxide and water.

There prevails an erroneous idea that fruit acids increase the acidity of the blood. Acid fruits often stir up digestive troubles with people whose blood is in an acid condition and who suffer from chronic inflammation of the stomach. In such cases a diet of fresh vegetables, preferably in salad form, is required, without salt and condiments, until normal conditions are restored.

The fruit acids, like the carbohydrates, are composed of three elements—carbon, hydrogen and oxygen. A short description of the principal organic acids is herewith given.

Acetic acid ($C_2H_4O_2$) is frequently found in organic form in many plants, combined with alcohol, and in ethers or essential oils. It forms salts with sodium, potassium, ammonium and other alkaline elements. These salts, or acetates, exist naturally in certain vegetable juices. In the animal body acetic acid and its salts are oxidized and changed into alkaline carbonates, in which form they are excreted by the urine.

Free acetic acid, as found in vinegar, is distinctly injurious to health, even more so than alcohol. It rapidly breaks down the red corpuscles and causes anemic conditions. In the preparation of salads, lemon juice should be used instead of vinegar.

Citric acid ($C_6H_8O_7$) is contained in many fruits, such as lemons, tomatoes, etc., or combined with alkaline salts, as citrates, in

all the citric fruits, quinces, currants, gooseberries, strawberries, raspberries, cranberries and many others. Citric acid is absorbed from the alimentary canal, and partly decomposed and excreted by the kidneys, as sodium carbonate.

Malic acid ($C_4H_6O_5$) occurs in a free state in apples, pears, quinces, sour cherries, pineapples, grapes. currants, blackberries, etc., or in combination with alkaline bases, as malates, in sweet cherries, apples, rhubarb, gooseberries, grapes and strawberries. These fruits usually contain malic acid, besides a malate of potash, calcium and magnesium. Malic acid is combined with citric acid in unripe apples, grapes, pineapples, gooseberries, cherries, bilberries, strawberries, etc. Malic acid, or malates, are also found in potatoes, carrots and parsley.

Lactic acid ($C_3H_6O_3$). This acid arises during the process of fermentation of milk sugar or lactose, as in the souring of milk, cheese making, and ripening of cream. Lactic acid is also found as a side product in the fermentation of various sugars, starches and other substances in the presence of protein. It is a thick, sour hygroscopic liquid which can be mixed easily with water or alcohol in any proportion.

Tartaric acid ($C_4H_6O_6$) is one of the most common organic acids in the vegetable kingdom, especially in grapes and other fruits. During the final stages of fermentation of grape-must a considerable quantity of cream tartar ($KaC_4H_4O_6$) is deposited. The gradual disappearance of organic acids as the fruit ripens, and the simultaneous increase of sugar and other carbohydrates indicate their transformation into sugars and starches.

Gallic acid ($C_7H_6O_5$) is widely distributed in vegetables, especially in the form of compounds known as "tannins." It is found as such in the leaves of many plants, especially in the leaves of black and green tea.

Tannin ($C_{14}H_0O_9$) is found in gall nuts, in all kinds of bark and the skins of fruits. It is colorless and readily soluble in water.

Tannic acid (CH_2O_2) is contained in small proportions in honey, where it acts as a preservative. It is also found in nettles. It is colorless, can be easily mixed with water or alcohol, and has a pungent odor resembling sulphurous acid.

Oxalic acid ($C_2H_2O_4$) is widely distributed throughout the vegetable kingdom, sometimes in the form of oxalate. Sorrel, spinach,

rhubarb, cacao, black tea and pepper contain from two to four per mille in the fresh material. Contrary to popular opinion, tomatoes show a very small amount, less than .005 per mille. Their sour taste is due to the presence of citric acid. As oxalate of calcium it is found in lichens and in the leaves and roots of many plants.

Oxalic acid, when taken in food, circulates through the animal tissues and fluids either as the free acid or as a salt, usually calcium salt. In the normal and healthy body it undergoes oxidation into carbon dioxide and water. If, on account of high acidity of the blood, the metabolism is faulty, a part of the oxalic acid may pass into the kidneys unchanged, giving rise to the formation of calcium oxalate stones in kidneys and bladder.

As shown in the following table, the amount of oxalic acid in most of our common foods is very small:

Amount of Oxalic Acid in 1000 parts of fresh substance, according to Esbach:

	Per Mille		Per Mille
Cocoa	3.52 to 4.50	Raspberries	0.06
Chocolate	0.724 to 0.90	Oranges	0.03
Infusion of tea, 5 min.	2.06	Lemons	0.03
Pepper	3.25	Tomatoes	0.002 to 0.050
Coffee infusion	0.13	Asparagus	0.028 to 0.044
Sorrel	2.74 to 3.63	Brussels sprouts	0.02
Spinach	1.91 to 3.17	Endive	0.02
Rhubarb stems	2.47	Strawberries	0.01
String beans	0.06 to 0.21	Apples	0.01
White beans	0.31	Watercress	traces
Beet roots	0.39	Radishes	"
Wheat bread	0.047 to 0.130	Grapes	"
Potatoes	0.05	Pears	"
Buckwheat flour	0.17	Apricots	"
Cabbage	0.31	Peaches	"
Cucumber	0.251	Melons	"
Carrots	0.030	Flesh	"
Salsify	0.070	Cauliflower	none
Dried figs	0.270	Lettuce	"
Cherries	0.025	Milk	"
Currants	0.13	Rye	"
Prunes	0.12	Lentils	"
Chicory	0.10	Green peas	"
Plums	0.07	Red wine	"

The amount of oxalic acid in cocoa and black tea is especially high, and an over-indulgence in these drinks, combined with an acid-forming diet, will greatly favor the formation, or the deposit, of

urates and oxalates in the kidneys and bladder. All conditions that favor the increase of uric acid in the body, such as a high protein diet combined with demineralized foods, will also contribute to the formation of oxalates.

In the accompanying table the amount of fruit acid in some of the best known fruits is given. As already stated, fruit acids are not free acids, but organic acids. In other words, they are integral parts of the cells, the same as organic salts. There are generally different kinds of acid found in one kind of fruit, but in the present table, the predominating acid is considered. In cranberries one of the acids is benzoic, amounting sometimes to as much as 0.05 per cent.

SUGARS AND ACIDS IN FRUITS

Variety	Fruit Sugar Per Cent	Fruit Acid Per Cent	Kind of Acid
Apples, Rhode Island Greening	11.	0.70	malic
Apples, Wine Sap	12.	0.50	"
Apples, Northern Spy	12.	0.70	"
Apricots, fresh	10 to 13.	1.	"
Apricots, dried	50.	2.50	"
Blackberries	6 to 8.	0.8 to 1.	"
Cherries	10 to 16.	0.90	"
Cherimoya	18.40	0.06	"
Cranberries	1.52	2.30	"
Currants	6 to 8.	2.25	"
Gooseberries	10 to 13.	1. to 1.50	"
Grapes	8 to 25.	0.5 to 1.	tartaric
Grapefruit	5 to 10.	1. to 2.	citric
Huckleberries	7.	1. to 1.60	malic
Lemons	1 to 2.	5. to 6.	citric
Limes	1 to 2.	5. to 6.	"
Loquats	10 to 12.	1.	malic
Mangos	13 to 14.	0.3 to 0.50	malic and tartaric
Oranges	5 to 12.	1. to 1.50	citric
Papayas	10.	0.07	malic
Peaches	8 to 10.	0.5 to 0.90	"
Pears	9 to 14.	0.20	"
Pineapples	9 to 12.	0.60	malic and citric
Pomegranate	16 to 17.	0.6 to 1.	mostly citric
Plums	14 to 16.	0.75	malic
Prunes	16 to 18.	0.3 to 1.	"
Quinces	9.	0.60	"
Raspberries	6 to 8.	1. to 1.50	"
Strawberries	6 to 8.	1. to 6.	malic and citric
Tamarinds	30 to 32.	6. to 12.	citric and tartaric
Tomatoes	4.	0.50	mostly malic and citric

CHAPTER X

The Organized Mineral Elements or Organic Salts

"The Missing Link in Dietetics"

We have learned that of the eighteen elements composing the human body, carbon, oxygen, hydrogen and nitrogen are the chief constituents of proteins, fats and carbohydrates. We shall now consider the other so-called mineral elements and their relationship and importance in the organic world. They are:

The acid binding basic or alkaline elements:

Potassium	(K)
Sodium	(Na)
Calcium	(Ca)
Magnesium	(Mg)
Iron	(Fe)
Manganese	(Mn)
Aluminum	(Al)

The acid forming elements:

Phosphorus	(P)
Sulphur	(S)
Silicon	(Si)
Chlorine	(Cl)
Fluorine	(Fl)
Iodine	(I)
Arsenic	(As)

The characteristics of each of these elements and their relation to each other in the living body, which is a most interesting and instructive study, giving the key to all dietetic reform, will be taken up in this and following chapters.

A normal man weighing 150 pounds is composed of about:

90 lbs.	of oxygen	3½ oz.	of sulphur
36 lbs.	of carbon	3 oz.	of potassium
14 lbs.	of hydrogen	2½ oz.	of sodium
3 lbs. 8 oz.	of nitrogen	2 oz.	of fluorine
3 lbs. 12 oz.	of calcium	1½ oz.	of magnesium
1 lb. 4 oz.	of phosphorus	¼ oz.	of silicon
4 oz.	of chlorine	⅙ oz.	of iron

Traces of manganese, iodine, aluminum and arsenic.

The chemical elements in the human body of the same weight, 150 pounds, are found in the following organic combinations and approximate quantities.

Water	90 lbs.	
Nitrogenous matter (protein, gelatin, etc.)	30 lbs.	
Fat (adipose tissue)	22 lbs.	
Phosphate of lime	5 lbs.	12 oz.
Carbonate of lime	1 lb.	
Chloride of sodium		6 oz.
Fluoride of calcium		3 oz.
Sulphate of soda		1½ oz.
Carbonate of soda		1¼ oz.
Phosphate of soda		1 oz.
Sulphate of potash		1 oz.
Peroxide of iron		⅓ oz.
Phosphate of potash		¼ oz.
Phosphate of magnesia		¼ oz.
Chloride of potassium		traces

Although the organic salts make up only a comparatively small amount of the body—about five per cent—they are nevertheless essential constituents, and every element has some distinct and necessary physiological function to perform. The normal and healthy development of the organism primarily depends upon an adequate supply of the organic salts, which are necessary in the life processes of plants and animals.

The organic salts enter the system as fully oxidized compounds and, therefore, furnish practically no heat and energy. Nevertheless, they hold the key to nearly all of the material manifestations of life. They are indispensable in the formation of cells and tissues, giving them firmness and form. They are the conveyors of vital electricity and magnetism, constantly recharging the human dynamo; they are the carriers of the life-giving oxygen to all parts of the body.

They are the essential factors in digestion and assimilation, as ingredients of the digestive juices regulating the osmotic exchange between lymph and blood and cells.

They are the scavengers of the body and the purifiers of the blood, neutralizing the waste products, uric acid, carbonic acid, etc., and assisting in removing them from the system. They are the real *materia medica,* which remove one of the fundamental

causes of disease, and restore the equilibrium of perfect health; they are nature's real antitoxins, giving vital resistance to every cell and thus making the system invulnerable to all so-called "germs of disease"; they are the foundation upon which a new system of living and healing must be built, which utterly rejects all poisonous drugs, vaccines and serums.

This particular and important branch of food chemistry has not received heretofore the degree of attention which it deserves, and it may be aptly called *"the missing link in dietetics."* It is a most significant fact that medical textbooks pay very little attention to the importance of mineral elements in the body. No system of cure can be complete and efficient which does not give paramount consideration to the mineral elements in food. The laws of life and growth are very closely interwoven with the characteristics of these elements. The problems of healthy and adequate nutrition cannot be solved satisfactorily without the most extensive and careful study of all the physiological functions of the organic salts, and their relation in the system to each other.

So far the majority of investigations have been made from the standpoint of agricultural chemistry. The Englishman, Sir Humphrey Davy (1778-1823), who was the first scientist to recognize the mineral elements that are essential for the development of plants, says in his "Elements of Agricultural Chemistry" (London, 1814):

"The chemistry of the simpler manures (the manures which act in very small quantities, such as gypsum, alkalis, and various saline substances) has hitherto been exceedingly obscure. It has been generally supposed that these materials act in the vegetable economy in the same manner as condiments or stimulants in the animal economy, and that they render the common food more nutritive. It seems, however, a much more probable idea that they are actually a part of the true food of plants, and that they supply that kind of matter to the vegetable fiber which is analogous to the bony matter in animal structures."

In Germany it was principally Liebig (1803-1873) who in the middle of the nineteenth century made very important researches and demonstrated the absolute necessity of mineral salts in plants, and who ascribed certain diseases of plants to the deficiency of mineral matter in the soil. Fungi and animal parasites can develop only on protoplasm having a deficiency in certain mineral elements.

Thus iron, sulphur and lime are injurious to microbes and insects, which cannot live and propagate on foliage and fruits rich in these elements. Yet farmers go on spraying and fumigating instead of investigating the condition of the soil and restoring it to its normal state.

In a normally developed plant each element is present in a definite proportion. Perfect growth cannot be expected when any one of the mineral nutrients is supplied in insufficient quantity, no matter what amount of the other mineral elements may be available. The production of the organic matter of a plant of definite size depends, therefore, upon those mineral elements which are present in even relatively small amounts. For instance, when there is but a small amount of phosphoric acid present, only a corresponding amount of nucleo-proteids can be produced. Likewise, potassium is essential to organic synthesis, and if there is but little available, the plant will depend on this amount, irrespective of the quantity in which the other mineral nutrients are supplied. This fact, which means that the size of the harvest depends upon the mineral elements present in the least amount, is known as "Liebig's Law of the Minimum." Liebig derived this law from general principles, without closely investigating the special function of each mineral constituent. Liebig's work was taken up by Dr. Koenig and Dr. Wolff who made chemical analyses of a large number of human and animal food products, especially investigating their percentage of mineral elements. The tables contained in the last pages of the present volume are chiefly prepared from these sources.

The early food chemists paid no particular attention to the physiological functions of the different elements in the animal and human organism. The German scientists, Dr. Hensel and Dr. Lahmann, first took up the careful study of this highly important subject. Hensel also devoted much time to agricultural chemistry and demonstrated by his tireless investigations which, unfortunately, are not yet fully understood and appreciated, how even the poorest soil can be wonderfully improved. He taught that the intelligent application of mineral fertilizers will bring forth the most wholesome, tasty products which do not readily deteriorate; that plants require for their healthy and vigorous growth the various mineral elements in their right proportion; that an over

supply of nitrogenous compounds (ammonia) and a deficiency of minerals, produces a vegetation which has no vital resistance, and thus makes it an easy prey to disease, just as poorly nourished men and animals do.

Organic Versus Inorganic Salts

While Hensel clearly pointed out the mistakes of agriculturists, he committed a grave error in recommending the mineral elements such as his "physiological earths" and "physiological salt water," in their crude inorganic form as remedies for the human system. The same idea of administering inorganic salts as foods and remedies for men was also taken up by the homeopaths, first by Schuessler, who modified their use by giving them in a highly triturated form. These preparations are generally known as "tissue salts" or "cell salts" of the biochemic school, and are now widely advertised as therapeutic agents. The claim is made that, while the inorganic salts in the crude form, as they appear in the soil or in the common mineral waters, are not utilized by the system, by subjecting these salts to a continuous process of trituration in which the molecules of the salt are finally diffused evenly throughout the triturating medium, they become capable of assimilation. The brochemists believe that by the process of trituration the properties are changed in some mysterious manner. No doubt the elements in their inorganic form may be absorbed by the lacteals and enter into circulation, and may even produce some chemical changes or reactions, but they cannot perform any vital functions, no matter how finely they are triturated. They lack that imponderable vital electricity and magnetism which is imparted to them in the organic combinations of the vegetable kingdom.

Even the embryonic plant must feed on the organic compounds of the seed until its roots and leaves are grown. The elevation and characteristic change of inorganic into organic matter, which takes place principally in the green leaves of the plant, by means of the chlorophyll, is the starting point of all organic combinations. Chlorophyll is, therefore, a substance of great physiological importance in plant life. The general conditions upon which its formation depends are the electro-chemical effects of solar light, warmth and a certain amount of mineral matter, principally iron and lime salts. Plants which are normally green, become etiolated

or pale, and consequently diseased, if any of these conditions are not supplied. Only by the presence of chlorophyll is the plant enabled to utilize the inorganic carbon molecule, and convert it with hydrogen and oxygen into the organic combinations of starch and sugar, and ultimately—with nitrogen and other mineral elements from the soil—into higher organic combinations. The lower forms of plant life (like bacteria, fungi, and certain kinds of algae) have no chlorophyll and are therefore unable to feed on carbon dioxide. They are none the less plants, since they closely resemble the chlorophyll-bearing plants in details of form and structure, mode of growth and reproduction. Higher development in form and function, however, becomes possible only when the lower forms of life acquire the ability to assimilate iron and lime salts and to utilize the resulting combinations for the construction of nucleo-proteids.

We must, therefore, draw a sharp line of demarcation between organic and inorganic salts, as well as between vitality and chemical energy. Chemically the elements are always the same, whether they are found in the air, earth, plant or animal. It is only through the life-process of the plant that the constituents of air and soil become vitalized; and this property of vitality alone distinguishes, for instance, the atom of iron in the red blood corpuscles from that furnished in the form of inorganic "tissue-salts," or other artificial preparations. That some elements exist in our body in such combinations as are found in the mineral kingdom, or as can be produced in the chemical laboratory, does not justify us in calling them "inorganic," after they have become integral parts of the living organism. Still, in most of the medical and physiological textbooks, the mineral elements in foods and in the body are termed "inorganic salts"; and this misleading denomination has also given the public the erroneous idea that the term "salt" refers to the common salt, or chloride of sodium, which is considered an indispensable adjunct to almost all foods. There are some people who believe that common salt makes blood and bone, and for that reason add salt even to the milk which serves as an exclusive food for infants!

The fact cannot be too frequently emphasized that there is a vital change going on in all the elements as they pass into the structure of the plant. On the other hand, chemical analysis or

separation of the elements means destruction of the living tissues; and, of course, the chemist will find in the elements of the "ash" the same properties that are found in the elements of the soil, but that subtle, imponderable force—vital electricity—has escaped. It cannot be isolated by the laboratory process of condensation or extraction. We must learn to recognize the mineral elements of the body as really "organic," integral parts of the living body and subject to the same vital changes—life and death—as the entire organism.

The phosphate of lime and the carbonate of lime of the skeleton, the iron contained in the red blood corpuscles, the phosphate of sodium, chloride of potassium, chloride of sodium, etc., found in the blood serum, are organized, and as such have a certain duration of life, during which they have vital functions to perform. Sooner or later the molecules will become fatigued or devitalized, according to the degree of their physiological activity, and they must be supplanted by fresh material. In other words, their biological existence is at an end when the vitality of the molecules imparted to them by the organism of the plant is used up, just as the death of the whole organism occurs when its vitality is depleted. Proteins present in the living body are combined with mineral elements, whereby the proteins concerned acquire specific properties and functional signification in the organism. We can hope to understand the living state of the protoplasm only when the complex organic combinations are recognized, chemically and biologically, as very changeable bodies which the slightest influence will often disintegrate into the more stable compounds of dead or inorganic matter. The higher the forms of life and the more intense the vital activity of the elements in the organism, the more subtle and refined their organic combinations have to be, and the more they are subject to change and renewal.

To illustrate: the comparatively stable molecules in the bones and teeth will last a longer time before they require replacement than the highly active atoms of iron, which are the oxygen carriers of the blood. The quantity of blood of a normal adult man of 160 pounds is about twelve pounds (7½ per cent of the body weight) and contains approximately fifty grains of iron. With every pulse beat nearly six ounces of blood are forced from the heart into the aorta, and, during every half minute, the entire quantity

of blood passes from the heart into the lungs and from there into the arteries and capillaries through the body. Consequently, the fifty grains of iron pass through the heart and lungs 120 times an hour and 2880 times a day. Within twenty-four hours, under normal conditions, the fifty grains of iron have to expend the same effort or vital action as 2880 x 50 grains or more than 20 pounds. The iron of the blood is a constituent of the hemoglobin, a protein compound making up the red blood corpuscles. The hemoglobin molecule is of enormous size, chemically considered, and iron makes up only the three-hundredth part of it by weight. Iron has the highest specific weight of all the elements entering the animal organism, being nearly eight times heavier than water. Therefore, nature had to construct such a large and highly complex organic molecule, in which iron occupies a small part, so that it could easily float along with the blood-current. To graphically illustrate this, the chemical analysis of the hemoglobin from horse blood, according to a German scientist, is represented by the formula: $C_{712}H_{1130}N_{214}O_{245}FeS_2$, showing more than 2000 atoms in one molecule. In natural foods iron is found solely in the form of complicated organic compounds which have been built by the life processes of plants. From these compounds hemoglobin is produced in the animal organism, which is not able to construct the highly complex organic molecule from inorganic substances.

Experiments have shown that animals slowly starved if they were fed only on a mixture of protein, carbohydrates and fat, all the mineral elements of milk chemically separated, but exactly in the same proportions found in whole milk; while animals which were fed exclusively on natural milk remained in good health. This is a most significant fact. Young animals can live on fresh milk alone. But if we put together artificially the constituents of the milk, which, according to the teachings of present-day physiology, are necessary for the sustenance of life, the animals die rapidly. The milk is an organic whole, in which the tissue salts are chemically associated with the organic substances, and only in this form are they able to sustain vital force. *The absolute necessity for electric and magnetic vitality in all of the atoms and molecules of food does away forever with the fanciful idea of some dreamers that some day we may be able to prepare artificial and concentrated foods in the chemical laboratory.* Nature knows

her business infinitely better than the expert chemists, and all attempts to imitate her intricate work will be failures from the very beginning.

The question of the absorption and utilization of different forms of iron in particular, was thoroughly investigated by Abderhalden, a German scientist, in an extended series of experiments upon several species of animals. He found that the animals fed with food poor in iron, plus an addition of inorganic iron, were unable in the long run to produce as much hemoglobin as those receiving normal food. While inorganic iron may be absorbed, it is not utilized in the formation of hemoglobin, but remains unused in the tissues. The same fact was found to be true clinically, and indicates that any apparent benefit is due to stimulation without the iron actually forming hemoglobin. Abderhalden also came to the conclusion that hemoglobin is derived essentially from the organic iron compounds of the food, while inorganic iron acts mainly, if not entirely, as a stimulant.

Chloride of sodium, or common salt, is another inorganic substance which has caused much confusion in the minds of people in regard to its necessity as an adjunct to our food. We constantly meet such statements as these: "It is the only substance which we take into our bodies directly from the mineral elements; and the desire for salt is instinctive with nearly all animals"; or "Common salt is one of the most essential of the mineral constituents of the body. When sodium chloride is entirely withheld from an animal, death from salt starvation ensues." Both of these assertions, and many similar ones, are almost diametrically opposed to the truth. Why should chloride of sodium be an exception to the other elements? Because an article has been largely used as an article of diet perhaps for thousands of years, does not entitle us, without unbiased investigation, to consider it wholesome. The salt-eating habit may be acquired as any other unhygienic habit, and, if we choose our food rightly, there is absolutely no necessity for it. The advocates of salt point to the animals who often go for miles to so-called "salt licks," but that fact does not by any means demonstrate that salt serves as food or performs some vital functions in the organism. This craving for salt is in most instances caused by feeding the cattle on herbage grown on soils poor in mineral elements, especially sodium, as on mountain slopes

where rains have carried away the most soluble parts of the soil and deposited them in the valleys.

It has also been observed that herbivorous animals after the winter months, when they have subsisted mostly on barks and twigs of trees, become constipated and look scrawny for the lack of the alkaline elements which are supplied in the various grasses in spring and summer. When the ground is heavily covered with snow, often for months, they cannot obtain the needful organic salts and vitamins in sufficient quantities, but as soon as there is a plentiful supply of herbs and greens, they very seldom go to salt-licks, which, by the way, contain very little sodium chloride and are mostly composed of other minerals.

Extensive experiments made in Germany with the horses of ten squadrons of cavalry and two batteries of artillery, during two years, showed that the animals, if they had their choice, preferred the unsalted fodder. If half an ounce of salt was added to their daily rations, they ate them without difficulty, but if an ounce was given, they showed apparent disgust. In every instance the use of salt was rather injurious than beneficial and did not increase the strength of the animals. With cows, a very small amount of salt increases the quantity of milk, but deteriorates the quality. Larger portions are decidedly detrimental, as the salt has a highly irritating influence upon all the tissues it comes in contact with. Professor Bunge assumes that the over-supply of potassium in some of the vegetable foods is the cause of desire for salt in the herbivorous animals. If a salt of potassium, such as potassium carbonate, meets with chloride of sodium in solution, a partial exchange takes place and chloride of potassium and carbonate of sodium are formed. This chloride of sodium is practically withdrawn from the organism and this loss seems to cause a craving for salt. Bunge further says that a man living chiefly on potatoes, for instance, takes in nearly one ounce and a half of potash salts a day. Cereals and pulses, generally used as staple articles of food, are likewise rich in potassium and poor in sodium. Man was never intended to be a potato or cereal eater, and the statements of Bunge only prove how urgently people need enlightenment in regard to their dietary habits. A combination of potatoes, cereals and pulses, with or without meat, is detrimental, since it is acid-forming. These foods, which at present make up the larger part of man's diet,

are, as a rule, not sufficiently supplemented by non-starchy vegetables, especially salad plants supplying sodium and the other alkaline elements. Furthermore, most of the vegetables are prepared so irrationally that their hygienic value is almost entirely lost. Salad is prepared with vinegar (which is worse than alcohol) and condiments; and the vegetables are boiled in water which is thrown away, together with the easily soluble salts, making them, of course, insipid and valueless. The consequence is that common salt is used in an attempt to restore the organic salts lost in the water. Thus the very purpose which the vegetables should serve, is frustrated by their irrational preparation. We should, therefore, always prefer those vegetables which we can enjoy in their natural and uncooked state. Those who will not dispense with table salt entirely should at least reduce its consumption to a minimum, not exceeding twenty-five grains daily, which is as much as will go on the point of a knife. Yet there are people who consume an ounce and even more per day, especially if they partake freely of salt butter, cheese, ham, etc. The following table gives the amounts of table salt in some commonly used foods:

Bread, average	25	to	30	grains	per	pound
Salt butter	⅓	to	1	"	"	"
Swiss cheese	⅓	to	½	"	"	"
Smoked sausage	½	to	¾	"	"	"
Ham	½	to	¾	"	"	"
Caviar	¾	to	1	"	"	"
Salt beef	1	to	1½	"	"	"
Salt pork	1½	to	1¾	"	"	"
Salt herring	1½	to	2	"	"	"
Cod liver oil	2½	to	3	"	"	"

Further attention must be called to the scientifically proved fact, that all foods which are kept in salt-water or brine, exchange some of the organic salts for the common salt by osmosis. Thus the valuable constituents are thrown away with the brine. Although the living cells of the body will protect themselves for some time against such mineral poisons, they will gradually lose their power of resistance. Salt is a strong diureter, subtracting from blood and lymph the necessary water for its excretion by the kidneys, a circumstance which causes abnormal thirst which is generally satisfied by stimulants and alcoholic beverages. All that may be claimed for salt is that it gives some palatability to emasculated

food, while the quality is in no way improved. But why deprive the foods of their natural organic salts and then add the inorganic table salt?

The old dietary standards with their larger amount of protein, and the fallacious estimation of food-values by the amount of calories, with entire disregard to the organic salts, have led to an over-consumption of meat, pulses and cereals, while the hygienic value of fresh fruits and vegetables is very much underestimated.

These conditions are well illustrated by the fact, that of the total amount expended for food, the American people spend about forty per cent for meat, about twenty per cent for dairy products, about twenty per cent for demineralized cereals and refined sugar, and only eleven per cent for fruits and vegetables. In other words, only eleven cents of each dollar spent for food goes towards the purchase of nature's most wholesome products. *In fact, Americans spend five times more money for refined sugar, artificial concoctions and manufactured sweets than for fruits.* Their annual expenditure for these items follows:

So-called soft drinks (mostly made with cane sugar syrup, artificial flavor and colors)	$ 350,000,000
Ice cream	250,000,000
Cakes and candies	350,000,000
Chewing gum	50,000,000
Refined sugar, molasses, etc.	500,000,000
Total, per year	$1,500,000,000
For fruits per year, only	300,000,000

In other words, the annual per capita consumption of fruits is less than $3.00 while that for artificial sweets in various forms is $15.00. Americans are fast becoming the best fed, but most poorly nourished nation on earth, from the lack of the needful organic salts in their daily food supply. The result is a rapid increase of nutritional diseases in spite of an army of over 100,000 physicians, who are only too prone to recommend surgical operations instead of a radical change in the patient's dietetic habits. The nutritive value of fresh fruits and vegetables is still very much underestimated by physicians and laymen alike, because foods are still judged by the amount of protein and calories they contain, instead of by the organic salts and vitamins.

The tables of analyses in the appendix show the proportion of mineral elements entering into the composition of the human body and most of the generally used food materials. We see at a glance that there is a great variation in the quantity and proportion of the different elements. The green-leaf vegetables have the highest amount of organic salts, especially sodium, iron and chlorine, which are very essential for the formation of normal and healthy blood. On the other hand, the milling products, like white flour, corn flour, and polished rice, which are paraded as "the staff of life," are poorest in the total amount of minerals, as well as in the amount of essential blood salts. The cereals are deprived, on an average, of seventy-five per cent of their mineral elements through the modern milling processes which, as experiments show, make them practically starvation foods. Meat ranks above the cereals in the total amount of salts. We must take into consideration, however, that the molecules in flesh foods have already lost a part of their vital electricity and magnetism by performing the life-processes in the animal body. In the organism of the plant these processes are chiefly constructive in storing up the vital forces in their organic combinations. Furthermore, we should consider that high degrees of heat, as employed in cooking, baking and frying, also produce certain biological changes in foods, and some of the mineral elements are separated from their organic combinations and reduced to the inorganic state.

In the Agricultural College of Greifswald (Germany) a number of interesting experiments were made to determine the difference between raw and boiled milk in the nutrition of the animal body. A litter of eight pups were divided into two groups, A and B, of which the one group was fed on raw milk, the other on boiled milk. During the course of the experiment, which lasted three months, no other food was given. The animals were weighed weekly, with the following results:

The first week the dogs of group A (raw milk) increased in weight more rapidly than those of group B (boiled milk). With the beginning of the second week the conditions were reversed, due to the accumulation of fat in the tissues of group B. A careful analysis of the blood showed that the contents of fibrin, albumin, organic salts, and consequently the specific weight of the blood, were much lower in group B than in group A. The tissues

of the bones of the former were far less firm than those of the latter group. The marrow of the bones of group B was decidedly anemic, the bones could be easily detached, while at the same time they showed a marked deficiency in mineral matter, such as potassium phosphate, calcium phosphate, magnesium phosphate, etc.

In boiling milk, the change which takes place is due to the coagulation of the globulin, or protein molecule, which splits away from the mineral molecules, and renders the combinations of iron and fluorine and the phosphate molecules unassimilable. Similar changes take place to a greater or lesser extent in the artificial preparation of all foods, whenever a degree of heat is applied that causes the coagulation or breaking up of protein molecule in which the subtle, imponderable vital forces are destroyed. Cooked foods, to be sure, can sustain life, but in the long run they cause a degeneration of the tissues and a lessened vitality and power of resistance. The dietetic and hygienic value of natural uncooked foods, therefore, becomes apparent.

By living during many generations largely on cooked foods, the organs of digestion and assimilation of the majority of people have been weakened to such a degree that they cannot properly digest uncooked foods, which require strong and powerful digestive juices. But the system will gradually adapt itself to natural foods again, if they are prepared judiciously and given in the right combinations. In fact, the organism responds quickly to the medicinal qualities of fresh fruits and green-leaf vegetables, which should be our only *materia medica* for restoring the normal physiological functions of the human body and for the increase of its powers of resistance.

CHAPTER XI

Variation of the Percentage of Mineral Elements and Their Polaric Distribution in Foods

In studying tables of food analyses one important fact is generally overlooked, viz., the wide variation in the chemical composition of the mineral matter in food products of the same kind, which is shown in table in the appendix. Thus we see, for instance, in cow's milk a variation of the total mineral matter from 0.35 per cent to 1.21 per cent; in grapes from 0.36 to 0.70 per cent; in potatoes from 0.42 to 1.46 per cent; in peas from 1.76 to 3.49 per cent, while soda, lime and iron vary as follows:

(Per Cent of Total Mineral Matter)

	SODA:	LIME:	IRON:
In milk	from 8.60 to 11.18	17.31 to 27.55	0.33 to 0.76
In grapes	from 0.29 to 10.54	1.70 to 22.60	0.05 to 1.68
In potatoes	from none to 16.93	0.51 to 6.23	0.04 to 7.18
In peas	from none to 3.54	2.31 to 7.90	none to 3.83

Again, according to Watts and other chemists, oxide of iron shows the following variations in different cereals:

Percentage of iron in total amount of mineral matter:

In oats	from	0.1 to 5.1
In wheat	from	trace to 3.3
In rye	from	none to 2.2
In barley	from	0.1 to 2.1
In millet	from	trace to 1.8
In rice	from	none to 1.4
In corn	from	0.5 to 0.8

Similar variations could very likely be detected in all food products grown in different soils. Such changes may go on slowly and imperceptibly; but in the course of years the soil may deteriorate to such a degree that its products become of an inferior quality, especially deficient in the essential organic salts. Men and animals subsisting on such abnormal foods will eventually show various signs of degeneration which reveal themselves in defective development of bones and tissues and in the lack of vital resistance or vital electricity. We must begin to look for the origin of so-

called contagious diseases—consumption, cholera, cancer, smallpox, etc., which are decimating the human race—in the devitalized cells and tissues of the organism, chiefly caused by faulty and perverted nutrition, and foods raised on impoverished soils, *and not by germs and bacilli.* We must learn to combat these diseases not by serums, vaccines and anti-toxins, but by reforming our dietetic and hygienic habits in accordance with nature's inexorable laws, and by intelligently improving the soil, and with it, the quality of our foods. As long as farmers continue to fumigate and spray deteriorated vegetation, instead of seeking for the cause of such deterioration; as long as doctors, being unable to distinguish between cause and effect, inject vaccine and serums into degenerated tissues, just so long will disease decimate mankind, notwithstanding the much-lauded progress of science.

The average college-bred physician accepts the established dietary standards as something axiomatic and not to be questioned. He is not aware of the relation which food bears to health and disease and, therefore, loses the advantage of an important therapeutic agent. We have a number of pathological conditions which, according to the teaching hitherto prevalent, are regarded erroneously as totally heterogeneous and disconnected. This misunderstanding has produced innumerable "specialists," each one treating a particular organ or symptom, without considering the body as an organic whole. A perfect understanding of the characteristics of each of the eighteen elements which make up the human body, of their relation to each other, of their functions in nutrition, growth and elimination in the living organism, will go far toward establishing a correct method of diagnosing diseased conditions, thus simplifying pathology and therapeutics. While the investigations which have been made in this respect are comparatively few, yet they are sufficient to establish an intelligent view of the prevention of all disease. They will ultimately inaugurate a rational and liberating system of living on a new and solid foundation of physiological and biological facts.

Polaric Distribution of the Elements

The early agricultural chemists had already found that in plants as well as animals and man, the mineral elements are not equally distributed, but that certain elements predominate in

certain parts of the organism. Thus potassium, sodium, calcium, iron and sulphur generally pass into the stems, leaves and fruits of the plants, while potassium phosphorus and magnesium are the principal mineral constituents of the seeds and roots. This fact becomes apparent by a careful study of the tables of analyses contained in this book. The tendency of certain elements to accumulate in certain parts of the plants may be compared with the polaric distribution of the earth's magnetism which is strongest at its poles. This is probably due to the polaric accumulation of iron which is the principal source of magnetic power on our planet. Just as magnetic iron attracts the non-magnetic metal, so the mineral elements in the living organism of the plant, charged as they are with vital electricity and magnetism by the great central station of the sun, attract similar non-magnetic elements as well as carbon dioxide and ammonia. The latter, combined with water, form the carbohydrates, proteids and nucleo-proteids. We may always recognize in plants distinct parts or poles, characterized by the particular mineral elements which they attract and accumulate, viz.: the leaves, blades, stems and juicy fruits on one hand, and on the other, the seeds (grains, nuts, seeds, contained in fruits) which serve for the reproduction of the species. The polaric distribution can also be noticed to a certain extent in the seeds themselves. Here we find in the outer layer of the kernels an accumulation of calcium, sodium, magnesium, sulphur, fluorine and silica, while potassium and phosphorus predominate in the inner parts. Even in the cells a characteristic division of the elements in the cell walls from the interior parts can be detected.

In the human and animal bodies nature works according to the same principle. Here we find the principal anatomical parts—the muscular tissues, the cartilage, the skeleton, the blood, the organs, etc.—likewise characterized by the polaric accumulation of certain mineral elements. The muscular tissues or meat, being rich in potassium and phosphorus, resemble in their chemical composition the seeds, while the skeleton, blood and skin, with their large amount of calcium, sodium, magnesium, iron, silicon, chlorine and fluorine, may be compared with the stems, leaves and juicy fruits. Although sodium, chlorine, and iron predominate in the blood, the latter must necessarily carry a certain quantity of all the elements entering into the composition of the human body, be-

cause it is blood which carries them to the different parts and organs, nourishing and cleansing the tissues and creating heat, vital electricity and magnetism. If all the blood vessels are filled with oxygenated, nerve-vivifying blood, containing the due amount of organic salts, this must be of advantage to every part of the body. Under such conditions liver, spleen, stomach, pancreas and intestines, as well as lungs, kidneys and skin, harmoniously work together, supporting and complementing each other. Again, in the cells making up the various organs there predominate certain mineral bases and salts which determine their vital functions, attracting by means of their electro-magnetic properties similar atomic groups, and eliminating the worn-out material, thus controlling the processes of absorption, assimilation and excretion. It is also interesting to note in this connection the role played by the elements in the struggle for existence which led to the evolution of the different species of the plant and animal world. The quantity and proportion of the mineral elements in the food shaped the various kinds of protoplasmic cells, which served as bases for the size and form, growth and propagation of the numerous species of the organic kingdoms. An insufficiency or plentiful supply of one or more elements will always greatly modify the character of the vegetable and animal organism affected. In other words, the protoplasmic cells in each species depend for the continuation of their vitality on certain well-defined food materials. To illustrate: the silkworn lives exclusively on mulberry leaves, while beech-tree leaves would be poison to it, because the latter contain lime, magnesia and sulphur, elements which in large amounts are injurious to worms; and mulberry leaves contain considerably less of these elements.

The gigantic saurians that lived during the carboniferous age, millions of years ago, and whose fossils and bones we now find in the strata of limestone, composing the earth's crust, could only attain such enormous proportions by developing a large and bony skeleton. This in turn could be built only by feeding on the wonderfully luxuriant vegetation of that period, produced by a moist, tropical climate and a soil rich in calcium, magnesium, sodium and iron. In the course of time, floods, volcanic eruptions and earthquakes greatly changed the topographical and meteorological conditions of our planet, and these animals gradually became extinct.

The vegetation assumed a different character according to climate and soil, and could no longer abundantly supply the material for the formation of such enormous frames as supported their bodies. The remains of these antediluvian monsters, from which their imagined appearance has been reconstructed, ought to teach us that it is the skeleton, that part of the body richest in mineral elements, which gives animals and men their characteristic form, strength and power of resistance. When we further consider that calcium make up more than one-half of the entire mineral matter in the animal and human bodies, the important part of this element in the growth and development of the organism becomes still more apparent.

The chemical composition of the bones varies according to the size and age of the animal. They contain on an average

5 to 50 per cent of water
15 to 50 per cent of cartilage (a gelatinous substance)
5 to 20 per cent of fat
20 to 70 per cent of mineral matter, chiefly composed of phosphate of lime with some carbonate of lime, phosphate of magnesia and small quanties of other elements.

The ribs, for instance, are composed of about

34 per cent of cartilage
57 per cent of phosphate of calcium
4 per cent of carbonate of calcium
2 per cent of phosphate of magnesium
3 per cent of other elements

While the cartilage consists of

67.67 per cent of water
30.13 per cent of mostly gelatinous substance
1.20 per cent of organic salts

The organic salts of cartilage are made up of

26.66 per cent of sulphate of potash
44.80 per cent of sulphate of sodium
6.10 per cent of chloride of sodium
8.40 per cent of phosphate of sodium
7.88 per cent of phosphate of calcium
4.55 per cent of phosphate of magnesium

Cartilage contains more sodium than any other tissue in our bodies. The gelatin, which can be cooked from the bones, is a nitrogenous substance. While it has some cohesive force, it readily

decomposes if dissolved in water and exposed to light and air, and for that reason it should never be used as human food. The skeleton, on the other hand, chiefly composed of mineral matter, may last thousands of years, until it slowly decays by the action of moisture and atmosphere. All parts of our body which are rich in cartilage need a constant renewal of their component mineral elements for protection against decomposition. Foods too rich in carbonaceous and nitrogenous substances and deficient in minerals, which are so universally consumed today, lower vital resistance and give rise to all kinds of diseased and degenerate conditions. It is only when the necessary organic salts are combined with other organic substances (protein, etc.) that the latter are rendered suitable for healthy and adequate nutrition. *The mineral elements give firmness to the tissues and at the same time create that subtle, vital electricity and magnetism which are the sources of our resisting power against injurious influences. Perfect health can only be maintained when the vital force is stronger than the disintegrating effect of foreign substances and micro-organisms which pass into our system by means of air, water and food.* It is, furthermore, the presence of the alkaline minerals in normal quantities and proportions which protects the organism from constantly forming poisonous waste products, by neutralizing them and removing them promptly from the system. *As long as these facts are not recognized by the medical profession, it will continue to grope in error, hunting for "germs of disease," "discovering" antitoxins and serums, vivisecting, quarantining and disinfecting, cutting out organs, inventing "elixirs of life," compounding paralyzing drugs, and deriving its "knowledge" from the test tubes of the laboratory instead of directly from nature—the eternal source of all life, and the fountain of truth and wisdom.* How true are Goethe's words in his immortal "Faust":

> "Nature retains her veil, despite our clamors:
> That which she doth not willingly display
> Cannot be wrenched from her with levers, screws
> and hammers."

Agriculture suffers frequently from errors similar to modern medicine. Because the seeds of plants contain a considerable quantity of nitrogen, potash and phosphoric acid, these substances were considered the most essential plant-foods. A system of fertilizing was established on this theory, disregarding the fact that

the entire plant during the processes of growth requires quite different proportions of elements from those which may be derived from the seeds alone. Nitrogenous fertilizers are used extensively, and, apparently, they produce plants of luxuriant growth, bringing forth fruits of large size and attractive to the eye, but of inferior quality and little durability. It is the proper quantity and proportion of *all* the mineral elements which give the fruits and vegetables their intrinsic food value, and not their content of nitrogen, ammoniacal compounds and water. The usual manures supply plants with too much forcing material, artificially stimulating growth, and producing a vegetation which lacks the material firmness and the power of vital resistance, and, therefore, is subject to the attacks of fungi, parasites and all kinds of plant diseases.

No normal body substance can be formed by foods grown on soil in which some of the essential elements are deficient. The milk obtained from animals feeding on impoverished vegetation is naturally of inferior quality, no matter how carefully handled and pasteurized. The large mortality of infants must be largely traced to milk produced by animals feeding on vegetation grown upon impoverished soils, aside from the fact that cow's milk is not a natural food for human beings.

There is nothing needed more in agriculture and in the science of nutrition than a clear and correct understanding of the polaric distribution, relationship and functions of the elements which build the organic world. It is only such knowledge that will help us to deal intelligently with the problems of health and disease, and dissipate the old superstitions which still hold their sway.

The mineral elements entering into the composition of the human body, with the exception of sulphur and iron, are not found in nature in the uncombined or elementary state. Taken as such they would be more or less injurious and even poisonous to the system, on account of their great affinity for oxygen and other elements, which would rapidly disintegrate all organized matter. It is only in their various chemical combinations with other substances that the elements become so modified that they can serve as foods for plants, which, in turn, transform them into still higher forms of organic combinations, enabling them to perform various complex vital functions in the animal and human organism.

It should be emphasized that the generation of vital electricity

and magnetism, on which the function of the brain and nervous system depends, is the primary function of all food-substances, while the production of heat is of secondary importance. For that reason, the determination of food values by calories is misleading. Chemically pure albumen, refined sugar and starch, substances giving about 1750 calories per pound, cannot maintain life. In fact, they would exhaust the vital forces sooner than the total abstinence from all food, because they are deprived of the organic salts, which are necessary for the generation of vital electricity, and for the reduction and elimination of waste matter.

Another point to be mentioned here is that blood rich in alkaline salts makes the digestive juices stronger and more effective, abstracting, therefore, more nutriment from a certain quantity of food than when the blood is in an acid condition, which is apt to impair the action of the digestive juices.

Equally important is the proportion of organic salts contained in food for healthy and adequate nutrition. A dietary may contain the necessary amount of calories, but the organic salts may be present in deficient quantities or wrong proportions. Mother's milk which is the natural food for the growing infant, indicates approximately the right proportions of the different organic salts which should constitute our food-supply. It contains:

33.80 per cent	Potash
9.10 per cent	Soda
16.70 per cent	Lime
2.20 per cent	Magnesia
0.22 per cent	Oxide of iron
22.70 per cent	Phosphoric acid
0.95 per cent	Sulphur
0.02 per cent	Silica
14.30 per cent	Chlorine
Traces of	Fluorine

It should be noted, however, that the growing organism needs more phosphate of potash and lime for the formation of bone and tissues than does the adult who needs more of soda, iron, sulphur and silica. Under normal conditions nature has stored a supply of iron in the liver and spleen of the newborn, seemingly to protect the body against possible deficiency of this important element which may occur in the food supply.

The foods which constitute the larger part of the average dietary, meat, cereals, and pulses, are too rich in phosphate of potash and deficient in iron, lime, soda, magnesia, sulphur, silica, and fluorine, a circumstance which is productive of many diseases, whose origin was hitherto obscure and falsely attributed to external causes, such as bacilli, germs or inclemency of the weather.

CHAPTER XII

The Acid-Binding Elements

The acid-binding, or alkaline elements, necessary for the growth of the human body, and the performance of its physiological functions, are potassium, sodium, calcium, magnesium, iron, manganese and aluminum.

Potassium (K) exists in inorganic nature in the form of chloride and sulphate of potassium in sea-water, or as deposits of rocksalt in the earth's surface; it is also found as silicate of potassium in feldspar and glimmer. This element never occurs in the free state, but can be obtained by electrolysis from chloride of potassium, when it appears as a brilliant white mineral, soft as wax, somewhat lighter than water, with a melting point of 145° F. It rapidly oxidizes if exposed to the air, but may be kept intact in coal-oil. If thrown on water it rapidly decomposes, the latter forming hydroxid of potassium (KOH), whereby such a degree of heat is generated that the liberated hydrogen burns with a blue flame, as it arises from the liquid, presenting the peculiar spectacle of seemingly burning water. The salts of potassium (potash) are found in large proportions in all plants. They are essential to the production of starchy fiber and the growth of grain and fruits. Without potassium there cannot be full development of plant or seed. Other things being equal, an increase of potash will increase to a certain degree the percentage of carbohydrates. Furthermore, potash is found to be present in larger proportions in those parts in which the carbohydrates are formed, as in all the connective tissues. As already mentioned, seeds always contain much more potassium phosphate than sodium phosphate, while on the other hand the proportion of soda to potash is found to be larger in the leaves and in a number of roots.

Potassium, if present in proper proportions, is a protection against parasites, fungi, insects, worms, etc. In places where insect pests occur, we find a deficiency of potassium, calcium, soda and iron; or the soil may contain these elements in such a state that they are not available to the plant. Phosphate of potassium

is the mineral basis of all muscular tissues, giving them their characteristic pliancy. All other organic salts exist in muscular tissues only in small proportions. Flesh is a very incomplete food, aside from the objection to the waste products it contains. It is adapted only to carnivorous animals, which are able to get their supply of soda, lime and iron by devouring the blood, bones and cartilage of their prey. Cereals, especially white flour products, show the same deficiency in organic salts as meat. Although the statement that "there is no life without potassium" cannot be contradicted, it should be modified, for potassium acts more favorably when the other elements are present in right proportion. An over-supply of this element is always injurious to organic life, and it is well known that, if contained in the soil in large proportions, or too frequently applied as a fertilizer, it is capable of producing poisonous effects. Experiments on wheat show that the roots make a much better growth in a mixture of chloride of potassium and chloride of sodium than in the pure solutions of these substances. It must be admitted, however, that potassium salts are of first importance in all processes of organic combinations of the elements. They are essential not only in the formation of carbohydrates and fat, but also in that of proteids, which are the principal organic compounds of the plant cell. In the synthetic processes of animal life, potassium salts are also indispensable. They play a part in the formation of glycogen from glucose, of fats from glycogen, and of proteids from peptones and proteoses. The liver, which is the principal organ in glycogen-formation, contains twice as much potassium as sodium, while in the spleen the proportion of potassium to sodium is one to four. Potassium is also a predominant element in the red blood corpuscles and in the brain, and we may conclude, therefore, that the element is in some way concerned in the generation of vital electricity and the functions of the brain and nervous system. Although potassium and sodium have similar chemical properties, they cannot be replaced by each other.

Sodium occurs in inorganic nature in the form of salts, generally as chloride of sodium in the water of oceans and salt seas, and, to a smaller extent, in spring waters. It is found as common salt in the strata of the earth's crust. As nitrate of sodium, or chili-nitre, it is found in large quantities in South America. As

silicate of sodium it is a constituent of many minerals. Like potassium it can be obtained in its elementary condition by electrolysis. It is a soft, white metal, melting at about 200° F. It rapidly oxidizes in the air and, if heated, burns with a yellow flame. It decomposes water, but the generated heat is not high enough to ignite the liberated hydrogen.

The view has been prevalent that sodium, although indispensable to animals, was of no special value to plants. So far no distinction has been made between the two fundamental functions of mineral salts which we now characterize as nutritive and protective. The protective function has not been understood until quite recently. Professor Osterhout of the department of botany in the University of California has made some interesting experiments in this respect. He says, in part:

"The whole subject was placed in a new light by Professor Jacques Loeb's formulation of balanced solutions which developed as the result of experiments on animals and demonstrated the protective action of sodium for muscle and nerve. I have shown in the last two years that this conception applies equally to plants. In proof of this I have shown that each of the ordinary salts of the soil (as well as of fresh water and ocean water) is poisonous for the plant when it alone is present in solution. We find, for example, that seeds placed in a solution of any one of these salts do not grow as well as in distilled water. Closer investigation shows that each of these salts has in addition to its osmotic effect a specific toxic effect according to its chemical nature. This is in the majority of cases due to the action of ions. We also find that we can counteract these poisonous chemical effects by adding certain salts which act as antidotes and which are therefore said to exercise a protective action. The same combination of salts which are beneficial for animals prove to be so for plants likewise. The agreement with the results from animals is complete, not only in principle, but even in details."

Experiments have shown that sodium is able to act as a means of protection against excess of other salts in the soil, principally those of potassium, ammonium, calcium and magnesium. The abundance and ease of application of soda salts give them special value for normal plant-growth. In the same way, sodium acts as a protective agent in animals. This discovery constitutes a very important point of agreement between animals and plants and has

a significant bearing on the theory of the unity of the phenomena of life.

In the animal and human organism sodium has many important functions to perform. In combination with chlorine it is one of the principal constituents of the lymph. For the transmission of the electric induction-current, which is generated in the nerve spirals by the iron of the blood, a salty liquid is necessary, as is shown by the construction of electric batteries. The normal blood serum contains for this purpose a comparatively large quantity of sodium chloride, which favors and sustains the generation and conduction of electric currents.

Sodium further serves to make the lime and magnesia salts in our food and, consequently, in the blood, more soluble and to keep them in a liquid state for perfect assimilation. Lime and magnesia, if not kept liquid by sodium, are soon deposited in the body, obstructing the capillaries, causing gall and bladder stones, paralysis, etc. Sodium also protects the blood from becoming too easily coagulated, the same as in the case of milk, where it keeps the casein, which is combined with lime and magnesia, in a liquid state. How very important sodium and sodium salts are for healthy nutrition appears, for instance, in the case of diphtheria. The real cause of this disease is a secretion of fibrin through the fauces from lymph and blood, because the latter does not contain enough sodium salts to prevent rapid coagulation of the fibrin. These salts have the property of redissolving even the coagulated fibrin and reducing it again to its liquid state.

Sodium also plays an important part in the formation of saliva, pancreatic juices and bile. In the latter, especially, the dissolving and reducing properties of the sodium salts can be very distinctly recognized in the emulsification and saponification of fats. Without a sufficient amount of sulphate of soda in our food, no normal bile can be formed, and grave disorders of the digestive functions, such as flatulency and constipation, will follow.

The deficiency of sodium in the blood is also one of the principal causes of diabetes, because of the inability of the system to take up sufficient oxygen to burn the carbon in the food.

It has been pointed out that the absorption of oxygen depends on the amount of iron in the hemoglobin of the blood. On the other

hand, the excretion of carbonic acid, as a result of the oxidation of protein, fat and carbohydrates, is carried on by the sodium phosphate and sodium carbonate contained in the blood and lymph.

This process is carried on in the following manner: sodium circulates in the blood as di-sodium phosphate, that is, in molecules which contain one atom of phosphorus to two atoms of sodium. While sodium phosphate is a staple union, the second atom of sodium is loosely connected with it. As soon as this additional atom finds a more powerful attraction, it separates and enters into a new combination. In this manner the carbon dioxide, resulting from the various processes of oxidation in the system, is taken up by the loose atom of sodium and turned into sodium carbonate again. This latter combination is not a lasting one, for as soon as it reaches the lungs through the veins, the carbon dioxide is discharged into the air, while the atom of sodium reunites with the sodium phosphate and continues its valuable function. In sodium we have, therefore, an indefatigable purifier of the system from poisonous carbonaceous waste products. Whenever there is a deficiency of sodium salts in the blood, the chemical changes between tissues and blood cannot be regulated, and excessive accumulation of carbon dioxide takes place in the body. The production of this waste product goes on, while its excretion is incomplete. Hence, we have the symptoms of carbon dioxide poisoning—pallid complexion, sour stomach, constipation and the proverbial "tired feeling." These symptoms generally occur more frequently towards the end of winter and early spring, as during the colder seasons the average diet consists mainly of meat, pulses and cereals, which are lacking in soda salts. Whatever vegetables are eaten are, as a rule, so irrationally prepared that they are of little food value. As a matter of fact, under the present methods of living, almost every individual suffers from a deficiency of soda in the blood as a result of a wrong selection of food and over-eating. In the causation of disease uric acid is not such a prominent factor as the accumulation of carbon dioxide in the fluids and tissues. Carbon dioxide causes a deficient circulation of the blood in the skin, and this, again, by preventing the excretion of waste products through the skin, is responsible for a persistent inclination towards "catching cold," which is really a synonymous expression for the retention of waste matter in the system. The

imperfect circulation of the blood in the body generally makes the process of oxidation more difficult, thus giving rise to the formation of abnormal products of tissue change. Consequently, all the processes of nutrition are functioning under difficulties and are incomplete, as the small part of oxygen absorbed is not sufficient for perfect oxidation. The accumulation of insufficiently oxidized proteins, as in the case of an excessive meat, pulse or cereal diet, gives rise to the formation of considerable quantities of free sulphuric and phosphoric acids, which, as they cannot combine with alkalies, will attack the tissues. This process takes place, for instance, in the so-called Banting-cure, in which emaciation actually results from the almost exclusive meat diet. Such a dietary, as also in the case of the Salisbury system, cannot be regarded as a rational cure, although it may temporarily remove some symptoms, not, however, without weakening the patient and lowering his general resisting power.

It is now admitted by all advanced physiologists that the power of the blood to resist disease depends upon its degree of alkalinity. Indeed, any body having blood rich in alkaline salts, and especially blood serum containing a normal amount of soda—the most important of the acid-binding salts—will show a high degree of resisting power against injurious influences and so-called contagious diseases, whether they be called smallpox, diphtheria, yellow fever or tuberculosis. *The medical profession does not yet recognize these important facts, nor does it realize that protection against disease must come from the development of strong and healthy tissues and not through vaccines, anti-toxins and serums.* In other words, prevention and cure of disease must come from sunlight, pure air and, above all, from a properly regulated diet, rich in alkaline salts.

If sodium is lacking in our food, and consequently in the blood, the bones will be attacked by the latter to supply the necessary alkaline salts to neutralize the acids, a condition which will cause diseases of the bones. In cases of rickets the blood often shows only forty per cent of the normal sodium and calcium contents.

A table in the appendix shows the amount of sodium contained in 1,000 parts of water-free substance of all foods so far analyzed. It is well worth careful consideration in selecting and combining our foods.

For the sake of comparison a smaller table with the sodium contents in foods is given below:

Sodium Contained in 1,000 Parts of Water-free Substance

Corn	0.02	Prunes	3.41
Walnuts	0.17	Apricots	3.76
Peanuts	0.21	Cow's milk	5.34
Pecans	0.36	Cauliflower	5.38
Almonds	0.38	Turnips	7.10
Beans	0.42	Apples	8.61
Wheat	0.50	Beets	9.00
Oats	0.59	Eggs	9.56
Rice	0.67	Whey	9.75
Cherries	0.76	Cucumbers	10.00
Oranges	0.95	Dried Figs	10.77
Potatoes	1.33	Cabbage	11.68
Yolk of Egg	1.44	Lettuce	13.55
Meat	1.44	Dandelions	13.63
Onions	1.55	Carrots	14.63
Cocoanuts	1.57	Asparagus	14.77
Olives	2.52	Strawberries	18.53
Human Milk	3.16	Radish	23.37
Tomatoes	3.40	Spinach	57.42

Cereals, pulses and nuts are low in the amount of sodium and should, therefore, form the smaller part of our dietary, while the bulk of our food should consist of fresh fruits and vegetables, giving always preference to those rich in organic sodium salts. If we observe this rule we will find that we can gradually dispense with the inorganic chloride of sodium or table salt, or at least reduce its use to a minimum, much to the benefit of our health.

Calcium is one of the most prevalent of the elements. As carbonate of calcium ($CaCO_3$) it is found in the form of calcium spar, limestone, chalk, marble, shells of eggs, mollusca, and corals, of which entire groups of islands are built. Sulphate of calcium and bicarbonate of calcium are readily dissolved in soft spring water. The element itself can be procured by electrolysis from molten chloride of calcium, when it appears as a light yellow metal, harder than lead, with a specific gravity of 1.58. Calcium in nature is always accompanied by more or less magnesium and, with the latter, represents the opposite pole to potassium (phosphate of potash) and ammonia, which predominate in all seeds and in the

muscular tissues of the animals, thus holding the balance to these substances. Calcium in connection with magnesium is, therefore, the mineral foundation of the entire skeleton, as well as the cartilages and tendons. Magnesium gives the bones a certain flexibility and protects them from becoming too easily fractured.

Magnesium occupies a position intermediate between the alkali metals and the alkaline earths. To some extent it also resembles heavy metal zinc. Magnesium is widely diffused in nature and several of its compounds are found in large quantities. It occurs as chloride and sulphate in many spring waters and in salt mines, as in Stassfurt (Germany). Metallic magnesium may be obtained by the decomposition of magnesium chloride, by sodium or electrolysis. Magnesium is an almost silver white metal with a specific gravity of 1.74, losing its lustre rapidly in moist air by oxidation of the surface. It decomposes hot water by liberating oxygen, and, when heated to a red heat burns with a brilliant bluish white flame, forming magnesium oxide.

Magnesium exists in the body principally as phosphate of magnesia in the bones, which contain about 50 per cent of phosphate of lime and one per cent of phosphate of magnesia. Yet this comparatively small quantity gives the skeleton its firmness and prevents softening of the bony tissues (osteomalacea). Our teeth are harder than our bones, because they contain 1½ per cent, or ½ per cent more phosphate of magnesia than the bones. This explains the fact that in exhumation of ancient skulls the jawbones are partly decayed and decomposed, while the teeth are still pretty well preserved. The ivory tusks of elephants contain 2 per cent phosphate of magnesium, and the billiard balls made from them are almost indestructible. The teeth of carnivorous animals contain nearly 5 per cent phosphate of magnesia, and, for that reason, they are able to crush and grind the bones of their prey without difficulty. This is another proof that man is not of a carnivorous nature, and that meat eating is only one of his acquired habits. Curvature of the spine and the premature decay of teeth have to be attributed also to the lack of this element in our food.

Magnesium, as well as calcium, iron and sulphur, also take part in the formation of the albumen of the blood. Magnesium is always found in much larger quantities than calcium in the muscular tissues, brain and nerves. Normal and healthy lungs

show twice as much magnesia as lime. We must consider the salts of magnesium as cell-builders, particularly of the nervous system and lung tissues. They are also instrumental in reducing foreign matter and waste, and in carrying them out of the system, thus invigorating the natural excretory organs and maintaining the natural fluidity of the blood and osmotic pressure, without which metabolism would be impossible.

Lime and magnesia also play an important part in the vegetable kingdom. Analytical investigations show that lime and magnesia are present in every part of the plants. The leaves contain relatively more lime, and the seeds relatively more magnesia than the other parts of the plants. These characteristics are the result of definite functions. The lime is necessary for the formation of certain calcium compounds of nucleo-proteids required in the organized structures of nuclei and chlorophyll bodies of the leaves, while the magnesium serves for the assimilation of phosphoric acid, as magnesium phosphate can release its phosphoric acid more easily than any other phosphate that occurs in plant juices. Thus calcium is chiefly required for the construction of plant tissue and at the same time facilitates the assimilation of other elements, while magnesium serves especially in aiding the assimilation of phosphoric acid. These two elements can exert their nutritive functions only while they are in a certain dependence upon each other. An excess of the former in the soil will lead to starvation of the plants, and predominance of the latter to poisonous phenomena in growth. Lime is necessary for the formation of the cell wall from starch and sugar. It practically forms the skeleton of the cell wall, and in that respect is just as necessary for the foundation of the bones. In fact, a higher development in form and function becomes possible only when the lower forms of life acquire the ability to assimilate lime and to utilize the resulting calcium proteid compound for the formation of nuclei. The greater the leaf surface of plants is developed in a certain time, the more lime is necessary. A normal crop of wheat requires per acre about 10 lbs.; sugar beets, 26 lbs.; grass, 43½ lbs.; clover, 98½ lbs.; and tobacco, 135 lbs., while a normal growth of wood needs annually about 44 lbs. of lime, besides 15 to 35 lbs. of magnesia, 4½ to 22 lbs. of potash, and 2 to 9 lbs. of phosphoric acid.

A deficiency of lime in the soil makes itself visible in diseased leaves and retarded growth. It has been found that etiolated or pale leaves contain less lime than do greener leaves. According to chemical analysis, 1,000 parts of green leaves contain 13.3 parts of lime, while the same quantity of etiolated leaves shows only 2.6 parts of lime. Diseased leaves of the sugar beet show only half the amount of lime present in healthy leaves. The favorable influence of lime on certain soils has led to the very common agricultural practice of liming.

Magnesium salts are especially important in the formation of seeds which are rich in phosphoric acid, but are also required by all other parts of plants, especially while in the process of development. Seeds rich in fat contain more magnesia than those rich in starch. The average proportion of magnesia in starchy seeds to that in oily seeds is about 2:5. In cereals magnesium is polarized in the outer coat or bran, which contains about four times as much of this element as the whole kernel, and about twenty times as much as the flour cells.

Magnesium salts can exert their nourishing functions only in the presence of calcium salts, while in the absence of the latter they have an injurious effect. On the other hand, the absence of magnesium salts in otherwise complete culture solutions leads to a gradual stoppage of all further development and to final inanition. The determination and balancing of the available amount of magnesia and lime in the soils is, therefore, an important factor in successful farming. While lime salts are indispensable for animals, the higher plants and algae, they are not so in the case of bacteria, fungi, and lower algae. Certain parasitic fungi and insects in the soil are easily killed by the alkaline properties of burnt lime.

In man and the higher vertebrate animals the lime salts make up more than 50 per cent of all the mineral elements composing the body. They are not only necessary for the formation of bones, but also for every part of the organism. Lime and iron are essential for the production of red blood corpuscles which are essential for proper respiration, since it is their function chemically to combine with oxygen. Without proper respiration the ingested food is oxidized incompletely and causes the accumulation of fat, which can be produced from sugar as well as from albumen. All protein mole-

cules are intimately combined with small quantities of lime salts which seem indispensable for many functions of the body, as, for instance, the beating of the heart and the contraction of the skeletal muscles. Lime, if properly absorbed by the body, exercises a strengthening, cohesive influence on the bony structure, and the strength of our sinews and muscles attached to the bones must vary according to the strength and firmness of our skeleton.

Calcium stands for strength and durability in the animal organism. In order to retain health and vitality the food should contain the necessary amount of organic lime salts. Without a sufficient amount of lime, firm and healthy bones cannot be built. Even in the adult the bony tissues must be renewed from time to time, as they are subject to change of matter like all the other tissues of the body. Blood vessels enter the bones. They supply them with the necessary material for growth and tissue changes. In this way the bones are furnished with phosphate of lime and the other elements entering into their structure. The arteries and capillaries bring continuously new material for the repair of all parts of the skeleton. On the other hand, the veins constantly carry off some of the worn-out lime salts for excretion. If there is a deficiency of lime salts in food, and consequently in the blood, the gelatine of the bones loses its chemical support and begins to decompose. Thus the teeth are first attacked from the inside by the venous blood, becoming hollow, while the saliva attacks them from without, dissolving the gelatinous matter which has lost its hold. In this way the teeth are deprived of their support in both directions and decay prematurely. It is often maintained that foods rich in lime tend to ossify the arteries and cause calcareous degeneration of the tissues. This occurs only in those cases in which the blood does not contain sufficient sodium salts to keep the phosphate of lime in solution. That there is lack of sodium in the usual diet of meat, white flour products and poorly prepared vegetables, has been pointed out. The habitual consumption of alcoholic beverages, such as wine and beer, likewise the use of vinegar, which are all deficient in mineral elements, also deprive the blood of organic salts, which are carried away by increased urination and the formation of carbon dioxide, resulting from the oxidation of alcohol. When wine and beer are drunk regularly every day, in time a condition must necessarily arrive when the blood does not contain

a sufficient amount of the essential organic salts for the formation of red blood corpuscles. It is then that asthma, corpulency and rheumatism appear.

The greater part of the calcium, magnesium and sodium salts are contained in the blood, bones, tendons and cartilages. These are devoured by the carnivorous animals, but are not food for man, who should chiefly derive his supply of these elements from fruits and vegetables. The usual meat and cereal diet, especially white flour products in combination with refined sugar, are wholly inadequate in the amount of the above-named organic salts. A large number of diseases, especially during childhood, where the tissue changes are most pronounced, must be attributed to this fact.

On account of the deficiency in lime, iron and sulphur, meat, especially that of fish, decomposes very rapidly. By salting and pickling the meat in order to preserve it, the organic salts are replaced through osmosis by the inorganic chloride of sodium, the former passing into the brine. It is mainly for this reason that people living largely on salted meat or fish suffer from scurvy and leprosy. Wherever there is a deficiency of lime in the organic world, we see an increase in development of invertebrate creatures, such as worms and maggots, parasites and fungi, which always indicate a deficiency of calcium, magnesium, iron and sulphur in the plants. A table containing the amount of calcium in 1,000 parts of water free substance in foods is given in the appendix.

It is, of course, irrational to prescribe lime for children in the form of inorganic compounds. In medical practice, rickety and scrofulous children are constantly being ordered to take a couple of teaspoonfuls of lime-water. Even if the inorganic lime could be utilized, the amount ordered would be far too small. A saturated solution of lime contains less lime than cow's milk. A pint of cow's milk contains 26 grains of lime; a pint of lime-water only 19 grains.

Green leaf vegetables rank highest in the amount of lime. Among fruits, oranges, lemons, strawberries, figs and grapes excel in this important element. Cereals are more or less deficient in lime, and therefore, contrary to the general opinion, do not cause hardening of the arteries, which is rather due to retention of waste matter, resulting from a high protein diet.

It has been estimated that the calcium requirements of the

average adult person are about 0.45 gram or 200 grains per day. This requirement must naturally increase in maternity, especially during the last three months of pregnancy, when the foetus is rapidly growing. A daily supply of green leaf vegetables in the form of salads is, therefore, absolutely necessary, not only to insure the normal growth of the unborn child, but also an easy parturition.

Iron, among all the heavy metals, is the most useful as well as the most widely and abundantly diffused in nature. It is usually found in small quantities in nearly all forms of rock, clay, sand and earth. It never occurs as a free metal, but chiefly combined with oxygen as ferrous and ferric oxides. Chemically pure iron has a silver white color and a specific weight of 7.8. It is, therefore, the heaviest element composing the human body. In inorganic form iron is generally combined with oxygen, sulphur, carbon and silicon. Silicates of iron, when decomposed by atmospheric carbonic acid, turn into carbonate of iron which is soluble in water containing carbonic acid, and is thus distributed by water all over the earth. Carbonate of iron, in coming in contact with the air, is oxidized into oxide of iron. The latter is again reduced by decaying organic matter into carbonate of iron and dissolved and carried off by water. We have in iron, therefore, a ceaseless oxidizing agent, preventing the retention of carbon in the soil and enabling it to return to the air, in order to begin anew the cycle of life.

In the organic world iron also plays an important part as a carrier of oxygen and stands in the closest possible relation to the fundamental processes of change of matter, or metabolism.

It has been pointed out heretofore that iron in the animal organism does not occur in an inorganic form, but as a small part of a complex organic compound. This is the most complicated compound that has been carefully investigated, containing as it does over two thousand atoms in a molecule and making up the red coloring matter of the blood, the hemoglobin, which first appears in the body of the vertebrate animals. The vegetable kingdom, which has the power of assimilating inorganic compounds of iron, builds up the complex organic compounds from which the hemoglobin is produced. Iron is taken from the soil and carried to the leaves, where it takes part in the formation of the chlorophyll granules, which is the green coloring matter of nature.

If plants are allowed to grow in solutions free from iron, the leaves become colorless or etiolated, but turn green as soon as iron salts are added to the liquid in which the roots are immersed. The amounts of iron and chlorophyll vary in the different parts of the plant. For instance, the green leaves of cabbage contain four times as much iron as the inner etiolated leaves. From many investigations it appears that in the bodies of plants, animals and man, iron serves for the following distinct purposes:

(1) For the production of the chlorophyll of the plant, principally contained in the green leaves, and of the hemoglobin of the red blood corpuscles.

(2) For the assimilation of carbon dioxide, and for the synthesis of organic matter from inorganic matter in the plant by means of the chlorophyll and sunlight.

(3) For the process of respiration in man and animals. It is the hemoglobin that carries the molecular oxygen through the capillaries to all parts of the body where the ingested food, which has been changed into blood and lymph and stored in the cells of the tissues, is oxidized or burnt.

(4) For the generation of a magnetic blood current and an electro-magnetic induction current in the nerve spirals which pass through the walls of arteries and veins and help to build and nourish them.

Chlorophyll, or the coloring matter of the leaf, which also needs for its production other mineral elements besides iron (such as lime and phosphoric acid), is closely related to hemoglobin, or the coloring matter of the blood, and the formation of the latter depends on the presence of the former. Only those cells in the plant that contain chlorophyll are capable of absorbing carbon dioxide. Without the latter the necessary proteins cannot be formed, as the plant must construct the highly complex protein molecule from the simplest inorganic compounds, viz., carbon dioxide, water, salts and oxygen, while the animal requires the organized substances for his nourishment. Proteins, like sugars and starches, are carbon compounds, containing as they do over fifty per cent carbon. As the carbon of the plant is governed by the chlorophyll, and the latter depends upon the iron, it follows that chlorotic or etiolated plants must contain less of carbon compounds than plants containing the maximum of iron and, consequently, of chlorophyll. Man and animals, in turn, partaking of such food cannot receive therefrom the chemical constituents necessary

for health. We should, therefore, pay attention not only to the food we eat, but also to the soil upon which it is grown. Indeed, it is the soil to which we have to look for the ultimate source of our welfare.

Iron plays such an important part in the prevention of disease, that all of its functions should be considered more carefully. Iron is found not only in the hemoglobin but in other cells and tissues of the body. It is also vitally concerned with the processes of secretion, reproduction, and development, standing, therefore, in fundamental relation to all the vegetative processes of the system. The iron of food, after the latter has been converted into chyme and chyle, is largely absorbed from the small intestines, entering the circulation by way of the lymph tract, and is deposited mainly in the liver, spleen and bone marrow. Its final elimination takes place chiefly through the walls of the larger intestines, especially the colon.

The total amount of iron in the human body is comparatively small and probably does not exceed seventy-five grains in the normal state of health. Of this quantity about fifty grains are contained in the blood, the remainder being distributed in the marrow of the bones, the liver and principally in the spleen. Iron is perhaps the most active element in the system and needs, therefore, to be renewed more frequently than, for instance, calcium and potassium. The body of an adult man needs about one-third of a grain (twenty milligrams) daily. Smaller animals need more iron proportionally than larger ones on account of increased respiration. While in man the amount of iron is about 0.2 per mille of the entire body weight, in a mouse it is over 0.4 per mille. In iron nature demonstrates how she can obtain the greatest results with the smallest quantities of matter. Upon the iron content of the blood depends, in the last analysis, not only its oxidation and circulation, but also the degree of vitality of the body. As Faraday demonstrated, the ferruginous blood is of a magnetic nature. By means of its circulation, which is partly produced by respiration, partly by the positive power of attraction of the nervous system and the negative condition of the blood, the iron contents of the latter become magnetic, and the blood itself acquires the magnetic power of attraction. This mutual, electro-magnetic power of attraction of the electric nervous system, by means of

the respired oxygen, effects the combustion of blood and nerve substance and simultaneously the liberation of the latent energy—heat, and, above all, electricity. The latter is largely stored up in all the natural foods, from which normal blood and nerves are formed.

The blood corpuscles play, therefore, a leading part in those tissue changes essential to life. Each corpuscle consists of a stroma permeated by a red fluid—hemoglobin—which readily combines with either oxygen or carbonic acid, but so loosely that, under slightly altered conditions, these gases easily separate from the corpuscles. In the lungs the corpuscles, through the hemoglobin, take up oxygen which they carry to all parts of the body. In its tissue metabolism, the red blood corpuscles yield up the oxygen which is necessary for the processes of combustion, and subsequently for the creation of animal heat and magnetism. After having parted with the oxygen, the hemoglobin unites with part of the carbonic acid produced by the tissue changes, and the corpuscles, thus re-laden, carry their burden back to the lungs and discharge the carbonic acid, taking up a new supply of oxygen. If the hemoglobin of the blood falls below a certain standard, the supply of oxygen necessary to healthy tissue changes, in brain, nerve, muscle, etc., becomes too limited, and all the metabolic processes will be performed imperfectly, the vitality lowered, and resisting power of the body lessened. A deficiency of hemoglobin is remedied by a supply of foods rich in organic iron compounds. Only the latter are able to promote the production of blood corpuscles, and cause each corpuscle to carry with it more hemoglobin; hence the specific health-giving power of organic iron.

The popular term "anemia," a condition which is generally indicated by pallor of the skin and mucous membranes, and mental and physical depression, is not accurately descriptive, since the blood of an anemic person really is not deficient in quantity but in quality. It is lacking in organic salts, especially in those of iron and sodium, and shows, therefore, a low specific gravity and a deficiency of red blood corpuscles. Comparing the blood of a healthy person with that of one suffering from extreme anemia,

great differences have been found, as is shown in the following table:

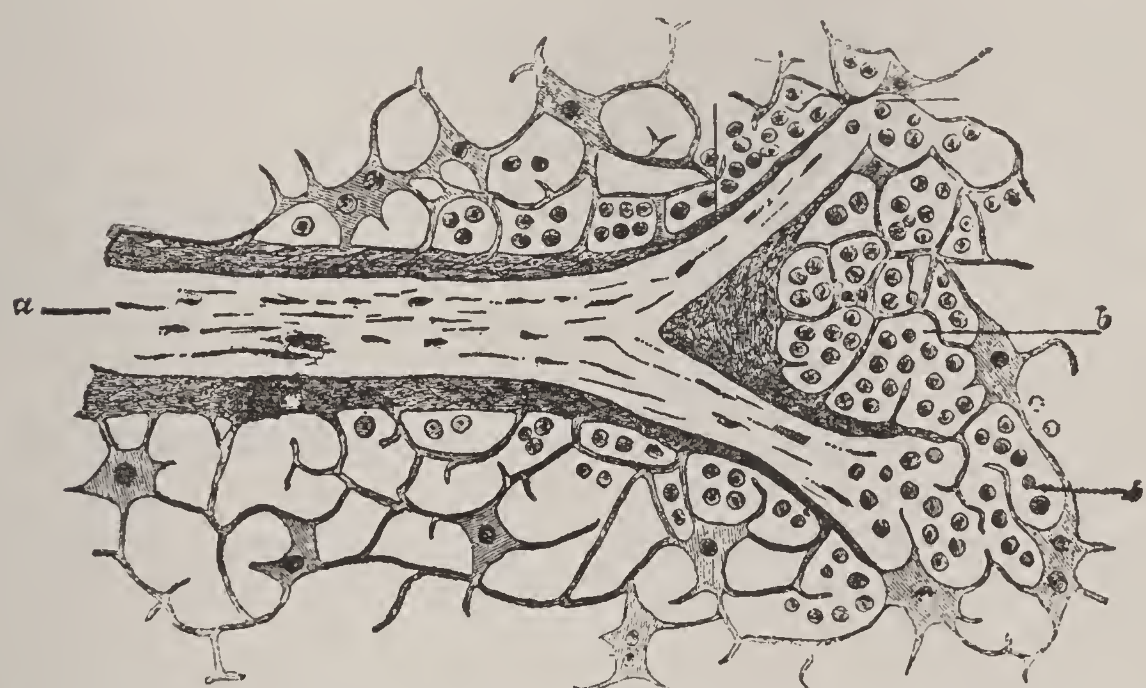
	In State of Health:	In Anaemia and Chlorosis:
Proportion of water	80 per cent	88 per cent
Proportion of solids	20 per cent	12 per cent
Specific gravity	1.055	1.035
Number of red blood corpuscles per cubic m.m. or small drop	4 to 5 millions	1 to 2 millions
Proportion of hemoglobin	12 per cent	2 per cent

Knowing that hemoglobin is the carrier of oxygen in and through the system, it becomes obvious that in certain instances a healthy and normal individual can take into his system at least six times more oxygen than one suffering from impoverished blood. It is, therefore, not only necessary that the oxygen enters the lungs, but that it should actually be absorbed into the system by the action of a sufficient number of red blood corpuscles. Those whose blood is anemic and whose vitality is low, because of wrong and inadequate nutrition, cannot derive much benefit from deep breathing and exercise in fresh air, before they have corrected their dietetic errors, and improved the condition of their blood and lymph.

That nature tries to protect the system from a deficiency of iron, by storing this element in the liver and spleen, is a most significant fact. Under normal conditions these organs store up a certain amount of iron to be drawn upon when there is a sudden demand for the rapid formation of red corpuscles, as, for instance, after heavy losses of blood. In the liver we find iron in various forms, from the simple oxide and phosphate of iron to the more complicated compounds which rapidly diminish after hemorrhages, or when the food does not furnish the requisite amount of this element. This circumstance indicates that the normal liver maintains the balance of organic iron in the system, thus repairing any accidental loss.

Most remarkable and characteristic is the function of iron in the spleen, an organ whose physiological importance has not been understood until within recent years. The spleen acts in our body as an electric power station where the blood is recharged

with electricity. This is effected by means of an apparently insignificant device by which the blood current is suddenly checked. As is well known, the arterial capillaries in all other parts of our body pass into those of the veins, but in the spleen the fine arterial capillaries terminate and become small sacs, which are called after their discoverer the "Malpighian corpuscles." There the circulation of the blood apparently is brought to a standstill. The following illustration shows the termination of an arterial capillary in the spleen, in linear enlargement of about 1:50:



a. Arterial capillaries of the spleen in longitudinal section.
b. Malpighian corpuscles, consisting of a delicate network, in the meshes of which lie ordinary lymphoid cells.

We know that the ferruginous blood is magnetic in character. The sudden impact of the magnetic blood current upon the walls of the Malpighian corpuscles has the effect of converting its magnetism into electricity. We must, therefore, assume that minute electric discharges take place from the spherical walls of the Malpighian corpuscles into the blood. That this is actually the case is shown by the fact that the fluid plasma which penetrates through the delicate membranes of the corpuscles contains certain fatty acids, which are the result of electrical decomposition of nerve fat. We know that the exceedingly fine nerve filaments of the spleen, which proceed from the solar plexus of the sympathetic system, accompany the ramifications of the splenic artery to the Malpighian corpuscles. The acid splenic secretion is taken

up by the venous capillaries, which carry it by means of the portal vein to the liver. Here the acids act as electric excitants, supplying the necessary electrical tension to the hepatic cells in order to secrete a strongly digestive alkaline bile. It becomes obvious that the action of the liver is dependent upon that of the spleen, principally in its iron contents. If, by a deficiency of this element, the function of the spleen is thrown out of order, we have no proper bile secretion, and, without the latter, no perfect digestion and assimilation. Consequently, malnutrition, impoverished blood, diminished nervous strength, and a lowered state of vitality soon render the body easily subject to any injurious influences.

The importance of iron in the vegetable and animal kingdom, and its relation to health and disease has been exhaustively treated by Professor E. F. Wright in his interesting and instructive book "Plant Disease," from which the following paragraphs are quoted:

"It can be taken as an axiom that in all fevers the active agent is a bacterium which is another name for one class of plants known as fungi. It is taught by many that it is the fungus which causes the chemical deficiency, while others say there must be a deficiency before the fungus can start its growth. I shall try to show that the first position is untenable. Some say that while the bacteria could not consume the iron, they might act on the blood chemically, so that the iron would escape from the system. This suggestion seems to be an impossibility, brought forward to support a bad case, because it has been proved over and over again that iron is fatal to all fungi, consequently it is unreasonable to suggest that bacteria would attack a perfectly healthy animal, and destroy the blood containing a constituent which was poison to them.

"Secondly, if bacteria could attack all alike, the natural conclusion would be that it would not be long before this fungi would have destroyed all higher forms of life from the face of the earth.

"That such is not the case, however, is proven by the fact that the majority of doctors and nurses in consumptive hospitals always remain immune to this disease.

"Further, it has been proven that where animals can obtain iron, they are much more immune to disease than in places where iron is wanting, from which we can only conclude that the presence of iron in the blood enables animal life to withstand the attacks of these bacteria, and as a corollary that the bacteria do not produce the deficiency, a conclusion which is further confirmed

by the fact that bacteria can only live on foods that correspond more or less with their own chemical composition.

"Another factor is that proteins are fatal to bacteria, and the fact that a normal hemoglobin which is of the nature of a protein, is a poison to these, explains why these fungi are never found in normal blood, for the all powerful reason that they could not live in it.

"This reduces the whole question again to the fact that a normal hemoglobin, through its various functions, renders the animal immune to an innumerable number of bacterial or fungoid diseases.

"In tuberculosis, it is universally recognized that oxygen is very beneficial, but the fact that thousands of cattle living in the open air suffer from it, shows that it is not sufficient that the oxygen should enter the lungs, but that it must be absorbed into the system, which can only be accomplished by the action of normal hemoglobin.

"It is clear from the above that in certain diseases at any rate, and, as I think, in most, the animal having a normal hemoglobin, is more likely to be immune than one whose blood is defective. In other words, if my conclusion is correct, the susceptibility to certain bacterial diseases is directly traceable to the use of chlorotic food. . . Animal life living on normal or the best foods, has its whole system worked as nature intended it should be worked. And as food degenerates from the normal, so do the functions of animal life degenerate, so that the greater the degeneration of the food, the greater the degeneration of the functions, and the degree of variation in degeneration accounts for the degree of variation in the virulence of a given disease in any animal attacked."

Accepting the conclusion arrived at by both experiment and practical experience, viz., that inorganic forms of iron are of no value in the vital economy of the system; that all the supply of iron must come from natural food stuffs, in which that element exists in the form of highly complex organic compounds, from which hemoglobin can be produced, we must necessarily devote some study to the iron contents of the various articles of diet. This knowledge will be of the greatest value in the treatment and prevention of all diseases arising from an impoverished state of blood.

While a most comprehensive table of the iron contents of foods is given with the other tables, we shall consider here only some

of the most frequently used articles of the human dietary, stating the amount of iron in 1000 parts of water free substance:

Fish	trace	Pinons	0.60
Meat of chicken	trace	Walnuts	0.61
White flour	0.03	Cherries	0.70
Polished rice	0.05	Carrots	0.70
Dates	0.06	Prunes	0.94
Bananas	0.07	Tomatoes	1.00
Human milk	0.07	Horseradish	1.25
Meat, average	0.15	Gooseberries	1.32
Beans	0.19	Rye bran	1.40
Unpolished rice	0.22	Cucumbers	1.40
White of egg	0.25	Pumpkins	1.88
Rye	0.25	Cabbage	2.16
Peanuts	0.27	Onions	2.20
Cow's milk	0.30	Swiss chard	2.30
Whole wheat	0.30	Asparagus	2.94
Wheat bran	0.38	Radishes	3.00
Oranges	0.38	Strawberries	3.73
Cocoanut	0.40	Rice bran	4.00
Yolk of egg	0.40	Spinach	6.05
Grapes, average	0.45	Leeks	7.60
Apples	0.46	Lettuce	9.40
Figs	0.60	Sorrel	9.85

In glancing over the above table we find the surprising fact that milk, which is the exclusive food of the growing organism, possesses a very small amount of iron. This is the more remarkable since all the organic salts are contained in milk in about the same proportion as they are needed for the growth of the newborn. According to the analysis of Professor Bunge, the total mineral matter in dog's milk and in the newborn puppy are composed as follows:

	Dog's Milk	Newborn Puppy
Potash	14.98 per cent	11.42 per cent
Soda	8.80 " "	10.64 " "
Lime	27.24 " "	29.52 " "
Magnesia	1.54 " "	1.82 " "
Oxide of iron	0.12 " "	0.72 " "
Phosphoric acid	34.22 " "	39.42 " "
Chlorine	16.90 " "	8.35 " "

The relative proportions of the mineral constituents, with the exception of iron, show but slight variation in each case. The amount of this element contained in the young animal is six times

larger than in that of the milk upon which it is fed. That the young animal grows rapidly and increases its blood supply in spite of this apparent deficiency of iron, is explained by the fact that the newborn is provided with a reserve supply of iron in its tissues. In a series of carefully conducted experiments with various animals, Bunge has shown that the amount of iron is the highest at birth, and that it gradually diminishes afterwards, until the animal is able to partake of the natural solid food for which its organism is adapted. Thus at least five times more iron is found in the liver of the new-born than in that of full-grown animals. Nature seems to have made this wise provision for the reason that the organic compounds of iron are apparently assimilated with great difficulty by the new-born. Hence, the material organism uses up its supply of iron with the greatest economy. The amount which must be conveyed to the infant organism could reach it in two ways: through the placenta or through the mammary glands. Nature chooses the former as the safer plan because the organic compounds of iron, if conveyed through the mouth and alimentary canal, might be decomposed by fermentative processes before they could be absorbed by the system. That nature protects the growing organism from a deficiency of iron is certainly proof of the great necessity for an ample supply of this element in building up the normal and healthy body.

Only a small quantity of iron is assimilated from the milk during lactation. Bunge showed that in young rabbits the absolute amount of iron remains nearly always the same, while the body increases in weight sixfold by the end of the fourth week. Consequently, the relative proportion of iron falls to one-sixth and the animals at this time appear to be already anemic. As soon as they begin to feed on grass and green leaves containing an abundance of iron, the amount of hemoglobin begins to increase again.

In the light of this knowledge, it seems very probable that children often become anemic if the milk diet is prolonged or too exclusively employed after the natural period of lactation. This is confirmed by many who have made close observation. For instance, Professor Rubner, a German physician of wide experience, makes the following statement:

"For many years a number of children's physicians have recommended that an exclusive milk diet should not be continued too long towards the end of the nursing period. For about ten

years I have myself adopted and have also taught the principle of giving other food as a supplement to milk after the infant has reached the age of nine or ten months, and this not only in cases of anaemia, but also in other rachitic conditions of rickety children, although I am not able to adduce any reason for this treatment. I may add that I was much pleased to read the first work published by Professor Bunge on this subject, and have followed his experiments with the greatest interest. Since then I have found it highly beneficial to give even vegetables to young children. In my practice I have met with the greatest astonishment on the part of the parents who consulted me, when I told them to give the child (which perhaps had eight teeth) a small spoonful of fresh spinach juice or scraped apple or something of the kind every day. This advice was the result of long and favorable experience.''

Again, Professor Monti of Vienna says in an article on ''Weaning and Nutrition'':

''If children are nursed up to the fifteenth month, they do not grow as they should, even when the milk is sufficient in quantity. They become anæmic, their muscles become flabby, and their development is delayed, so that, instead of attempting to walk at the end of the first year, they do not begin to do so until they are about eighteen or nineteen months old. There are certainly a few races with whom it is customary to nurse children after they have attained the first year. We have frequently had the opportunity of seeing some of these children, most of whom are of Slavonic parentage, and found in all cases a state of malnutrition. Other food than mother's milk is always required. The custom of prolonged nursing exists in France, in a few parts of Italy, and, according to hearsay, in Japan. All authorities are agreed, however, that the continuation of the nursing period beyond the proper time always induces disturbances in the child's nutrition, and that many cases of rickets must be ascribed to this practice.''

Bunge mentions a youth of eighteen years who had lived on nothing but milk from the time of his birth. The boy stated that he had occasionally tried a piece of bread or a pear, but that it had not agreed with him. He had an intense dislike to all animal and vegetable food. His face was pale, as well as the mucous membrane of the tongue and of the conjunctivæ. He suffered from cold feet and hands, was easily tired in walking, and had palpitation of the heart when he ascended the stairs. It was found that, although his blood contained five million blood corpuscles in the cubic millimeter (a quantity making up a small drop), it had only 8.6 per cent hemoglobin, whereas a normal

person has 12 to 16 per cent. The boy's condition was similar to that occurring in chlorosis. Furthermore, Bunge regards it as probable that many prospective mothers during the period of pregnancy do not assimilate as much iron as is required by the foetus.

It has been estimated that the normal child at birth has about ten grains of iron, of which two-thirds has been drawn from the blood of the mother during the last three months, so that it is very important that before and during this period the diet should furnish an abundance of iron, as well as sodium and calcium. During normal lactation the daily secretion of milk is about one quart. The iron requirement of the mother must be increased accordingly by a liberal supply of fresh fruits and green-leaf vegetables.

Next to milk, cereals, which are so-called staple foods, contain the smallest amount of iron, at least in the form in which they are generally consumed, when deprived of their outer coats. Chemical analysis shows that white flour and polished rice contain only one-half as much iron as human milk, and rice even ten times less than cow's milk. All grains contain iron, which varies, of course, according to the iron contents of the soil. The greater amount of the element, being stored up in the outer layers and in the germ of the kernel, is lost in the modern milling processes. The organic iron compounds of the germ seem to play an important part in the germination of the seed and the nutrition of the young plant which, similarly to the new-born animal, requires easily digestible and assimilable food. Experiments indicate that the iron in bran is also assimilated by the animal body, and promotes the formation of hemoglobin.

Fruits and nuts contain an appreciable amount of iron, strawberries and walnuts ranking highest. Of the vegetables, those bearing the greenest leaves always have the largest amount of iron compounds. But we must remember that in order to produce normal food products, special attention must be paid to the soil, which should contain an appreciable amount of iron. Frequent analyses of the soil are, therefore, of great importance.

In eggs the iron is mostly contained in the yolk, while the white contains only traces of it. Meat, as ordinarily eaten, the muscular tissues having been washed free from blood, contains but a comparatively small amount of iron. Fatty tissues are

nearly free from iron. The quantity of iron in fat meat is much less than that in lean meat. As the iron in meat is largely due to the amount of blood retained in it, anæmic persons have been sent to slaughter houses to drink the warm blood just as it came from the animal's body, but with apparently little success. The iron in the product of the dead animal naturally has a decidedly lower nutritive value than the iron compounds of the vegetable kingdom, as the animal organism—the hemoglobin molecule—has lost part of its vitality in the metabolic life processes.

The flesh of most kinds of fish is more or less deficient in iron. This is most likely the reason why people subsisting chiefly on peeled rice and fish are subject to severe skin and nervous diseases, such as scurvy, leprosy, beri-beri, etc., which have their origin in a degeneration of blood and lymph. During the campaign in the Philippine Islands, an army officer, while stationed on the Island of Samar, observed that many elderly people of that locality were victims of leprosy. When asked how the disease was contracted, they referred back to a time—some thirty years previous—when a terrible storm visited the interior of the island and destroyed all their trees and vegetable food products. They were compelled for months to live on fish and clams. They declared that the disease started at that time and the exclusive fish and clam diet was directly responsible for it.

The importance of green vegetables, especially prepared as wholesome salads, must, therefore, be particularly emphasized, since we are practically dependent upon the vegetable kingdom for the greater part of iron, which is found in plants in the form of highly organized ferruginous nucleo-albumens.

Manganese resembles iron in its physical and chemical properties. Its specific weight, 7.2, is a little less than that of iron, while it is slightly darker in color, considerably harder, and somewhat more easily oxidized. In nature manganese accompanies iron everywhere. It is contained in the red blood corpuscles, though in much smaller quantities than iron, and seems to have a decided influence on the vegetative functions and the glands in general, enabling them to improve the quality of their secretions. Like iron, manganese is an oxygen carrier from the lungs to the cells.

Traces of this element are found throughout the vegetable kingdom, and in considerable quantity in the ash of a few plants,

especially in the wood of some trees. Experiments have shown, however, that, physiologically, manganese cannot replace iron in plants in all instances, although the chemical properties of the elements are similar. Soluble manganese compounds may, on the one hand, be injurious to the chlorophyll, while, on the other hand, they may exert a beneficial action by stimulating the growth of the plant, especially when these compounds are supplied in a sufficiently high degree of dilution. A Japanese investigator in a field experiment with rice recently observed an increase of one-third of the harvest after adding sulphate of manganese to the soil at the rate of about forty pounds per acre. Great care should always be exercised in application of both iron and manganese compounds to the soil, as an over supply of these elements has a detrimental effect on the growth of plants and trees.

Aluminum is often found in foods of both vegetable and animal origin. It is present only in very diminutive amounts as aluminum oxide, or alumina (A_2O_3). Its chemical action is similar to that of magnesium.

CHAPTER XIII

The Acid-Forming Elements

The principal acid-forming elements in the body consist of phosphorus, sulphur, silicon, chlorine and fluorine.

Phosphorus is chiefly found in nature in the form of phosphates of calcium, iron and aluminum, which minerals form deposits in some localities, but also occur diffused in small quantities through all soils upon which plants will grow, phosphorus being an essential constituent in the food of most plants.

Phosphorus in its isolated state is manufactured chemically from bones, which contain fifty-eight per cent phosphate of calcium and four per cent phosphate of magnesium. The element appears as a colorless, transparent substance which has somewhat the appearance and consistency of bleached wax. In the course of time, and especially upon exposure to the light, it changes by degrees and becomes less and less translucent, gradually turns white, yellow and, finally, yellowish-red. It has a specific gravity of 1.83 and is brittle at the freezing point, until it fuses at 111° F., forming a yellowish fluid.

The most characteristic features of phosphorus are its great affinity for oxygen, and its luminosity. It is visible in the dark (phosphorescence), from which property its name, signifying "carrier of light," has been derived. Because of its affinity for oxygen, phosphorus has to be kept under water, as it invariably takes fire when exposed to the air. The slow oxidation takes place upon the surface of the phosphorus, soon raising it to 122° F., at which temperature it ignites and burns with a bright white flame, and gives off dense white fumes of phosphoric dioxide. Phosphorus is invisible in water, slightly soluble in alcohol and, if brought in contact with living tissues, causes burns. Taken internally it acts as a strong poison.

In the plant, phosphoric acid takes part in the formation of the very complicated compounds of the various forms of lecithin formula and nucleo-proteins, which are integral parts of every vegetable and animal cell. Phosphorus enters the animal body

chiefly in combinations, and only to a small extent as salts. Phosphorus leaves the body in the same form in which it entered the plant, namely, as phosphate. The embryos of plants can develop by cell division only when phosphates are stored up in sufficient quantities in the seeds for the formation and increase of the nuclear substance in the new cells. The yield of grain is increased much more by phosphoric acid than by nitrogen or potash.

In the vital processes of the animal, lecithins (phosphorus compounds), play a most important part. They have, in common with fats, to which they are closely allied in composition, the property of solubility in alcohol and ether. But at the same time they have the property of swelling in water, and of being somewhat soluble in it—a property which renders them physiologically superior to ordinary fats.

Lecithin seems to be essential to respiration, as it represents the form into which the fat must be changed to become oxidized in the protoplasm, since the substances serving for respiration must be present in the protoplasm in a dissolved condition. It is this peculiarity which enables lecithin to take part in many other chemical processes of the tissues. The brain and the nervous system contain an appreciable amount of lecithin, and the gray matter of the brain shows seventeen per cent of this substance, which is the essential and indispensable medium through which the higher intellectual forces manifest themselves.

Although phosphorus is one of the principal constituents of the brain, the expression of Moleschott, "no thought without phosphorus," is not justified, if it is meant to convey the idea that the amount of phosphorus passing through the body bears a causal relation to the intensity of thought. A captive lion or tiger assimilates and parts with a greater amount of phosphorus than a person performing difficult mental labor, while the excreta of a beaver noted for its powers of contrivance are so small that chemical analysis can hardly find it.

The greater the purity in which lecithin is found, the higher the intelligence of the animal, even in the smallest insects. The superior acuteness of senses displayed, for instance, by bees and ants, is due to this fact. It is not the quantity, but the quality of the highly organized phosphorus compounds which seems to be so vitally connected with the thought processes.

Chemically considered, lecithin is a combination of two portions of fat with one of phosphate of ammonia; it can also be formed directly from sugar, which is the chemical basis of all fats. Being easily combustible and having a large amount of potential energy in a small volume, lecithin is well adapted to sustain the ceaseless activities of the nervous system and the respiratory organs. As common oil burns in the wick of a lamp, so does our nerve-oil or lecithin burn in the fine ramifications of the wick-like nerve-fibres, by means of the oxygen supplied by the arteries and capillaries from the lungs.

It may be asserted that for the proper function of the brain a supply of phosphoric salts is necessary, but the same may be said with equal justice of oxygen, carbon, water, etc. The intensity of thought does not depend on a single element, but on a perfect working order of brain and nervous system, in which the compounds of phosphorus are essential. But this element itself does not produce thought, any more than do the other elements entering into the composition of brain and nerve cells.

In the organic world phosphorus is generally combined with potassium as phosphate of potash, and as such it makes up the greater part of the mineral contents of the seeds of plants and the muscular tissues of animals. All the organs and tissues of the animal body are to a considerable extent chemical combinations of phosphates and various proteins. The bulk of phosphorus, however, in vertebrate animals is contained in the skeleton. In the body of a normal man, weighing about 150 pounds, there are about thirty ounces of phosphorus, of which twenty-seven ounces are in the bones, a little over two and one-half ounces in the muscular tissues and about one-quarter ounce in the brain and nervous system. In cases of prolonged fasting the necessary amount of phosphorus is largely contributed by the bones, while the brain remains almost intact.

The water-free substance of muscles or flesh contains about four per cent of mineral matter, of which nearly two-thirds consist of phosphate of potash. Likewise, the water-free substance of seeds, such as cereals, pulses and nuts, shows from one to three per cent mineral matter, of which about one-half is composed of phosphate of potash. The accumulation of phosphorus in the nuclei-proteids of seeds and muscular tissues justifies us in con-

cluding that this element is a strong stimulant in the growth and development of new tissues, due largely perhaps to its great oxidizing powers. In this respect phosphorus is counterbalanced by sulphur, which plays the part of a regulator, protecting the organism from over-stimulated growth. The relation of phosphorus and sulphur in our foods is therefore worthy of careful attention.

Sulphur is found in the elementary state, mixed with earthy matter in volcanic districts, the chief supply being derived from Sicily. Considerable quantities also are mined now in Utah, Nevada and California. In combination sulphur is widely diffused in the form of sulphates and sulphides. Sulphur is a yellow, brittle, solid substance, having neither taste nor odor. It is insoluble in water and nearly so in alcohol. It melts at 239° F. and, if heated to 500° F., burns with a blue flame into sulphur dioxide (SO_2). Its specific weight is about 2.

In the organic world sulphur is built in the protein molecule of the plant from the sulphates taken from the soil. It is chiefly taken up by the animal organism in the form of protein, and secreted for the most part in the highest oxidized condition as sulphuric acid, derived from the splitting up and oxidation of the protein molecule. In this form, combined and neutralized by alkalies, it is again ready to begin the cycle of life, by forming organic sulphur compounds in plants.

Sulphur is a constituent of the hemoglobin of the blood, where is also serves as an oxidizing agent. It is noteworthy that, according to analyses, the animals requiring more oxygen have likewise more sulphur in their hemoglobin. Four atoms of sulphur in the hemoglobin of the horse, six in that of the dog, and nine in that of the chicken, combine with two of iron. Sulphur enters into the composition of albumen, gelatin, etc., in all of the tissues. It is one of those elements that make up the natural resisting power of the body, as the organized sulphuric acid salts have a cleansing and antiseptic influence in the alimentary canal.

All organic building material contains phosphorus and sulphur at the same time, although in very different proportions. The phosphates (the combinations of phosphoric acid with the basic or alkaline elements) serve preeminently the purpose of giving the actual impulse to growth. This is explained by the fact that we find phosphate of potash in all seeds which are intended to

give birth to new organisms. The seed that is put into the soil has, above all things, to grow as rapidly as possible, so that it can reach out in both directions, to send its tiny roots downward and small stem and leaves upward so that they may absorb further nourishment from earth and air. Seeds, in order to give the embryo plant every chance for growth, contain, therefore, comparatively little sulphur. Likewise, in the animal body those parts which are intimately connected with growth show a marked preponderance of phosphorus over sulphur. Thus we find that the skeleton contains a large amount of phosphate of lime and magnesia, the muscular tissues, phosphate potash, and the brain and nervous system, lecithin. While in the blood the proportion of sulphur to phosphorus is 1 to 2, it is, in the muscular tissues and brain, about 1 to 65.

Every impulse in nature, in order that it may not continue unrestricted, must be to a certain extent counteracted. It is in this manner that phosphorus and sulphur supplement each other. The easily inflammable phosphorus represents the centrifugal force; the somewhat inert sulphur, the centripetal force. All vital processes in nature ultimately rest on this principle of contrariety, arising from the different chemical affinities of the elements, as explained by Mendeleeff's periodic law. As a clock is regulated by a pendulum, so our body needs a regulating factor which gives the whole system a degree of balance. It is for this reason that normal blood plasma and blood serum have about equal quantities of phosphoric acid and sulphuric acid salts. This wise arrangement of nature prevents an unimpeded growth of those nerve filaments which terminate in the mucous membranes. The sulphuric acid salts of the blood coming, by means of the capillaries, in contact with the nerve terminations control the action of the phosphoric acid salts contained in the latter. In the processes of metabolism, which are always carried on by means of the electricity conveyed by the nerves, the sulphur of the blood takes hold of part of the oxygen which otherwise would combine wholly or to a large extent with the phosphatic nerve-fat (lecithin), producing a too rapid oxidation of the latter and consequent nervous disorders. Sulphur must always keep the balance in the body. Many diseases of the nervous system are due chiefly to the unbalanced proportion in which the elements of sulphur and phos-

phorus are supplied in the usual foods (princially cereals and meat). Such conditions as mental irritability, neurasthenia, abnormal sexual desires, insanity, etc., are very much aggravated by an excessive amount of phosphoric acid. Furthermore, an oversupply of phosphorus and nitrogen in our diet, with a simultaneous deficiency of sulphur and sodium, lead to abnormal tissue formations, such as polypi, tumors, elephantiasis, cancerous growths, etc. There are many pathological conditions which may appear to the uninformed physician as being entirely heterogeneous, but which in reality have the same source, viz., an insufficient supply of sulphur, sodium and calcium in foods, with a preponderance of phosphorus and nitrogenous compounds. For instance, obesity, asthma, rheumatism, diabetes, etc., are ofttimes merely different symptoms of one cause—the inadequate supply of sulphur, iron and calcium. These elements, supplied in natural foods, are the essential basis of normal albumen of the blood or hemoglobin. On the condition of the latter depends the capacity for absorption of oxygen in the organism, and, consequently, perfect oxidation.

Many diseases, which hitherto have been ascribed solely to the accumulation of uric acid in the system, are really caused by the consumption of foods which are too rich in phosphoric acid and deficient in sulphur. This is the case with all foods which abound in nucleo-proteids (although they may contain but very little uric acid), such as milk, cheese, eggs, nuts and cereals. These foods should never be taken as an exclusive diet, but always in small quantities, properly balanced with fruit and vegetables rich in sulphur to counteract the excessive amount of phosphoric acid salts.

The following table, which gives the proportion of sulphur and phosphorus in the most frequently used food-products, will be of special interest to the student of dietetics:

Proportion of Organic Sulphur and Phosphorus in Foods

Horseradish	1	:	0.25	Carrots	1	:	2.
Cabbage	1	:	0.65	Pineapple	1	:	2.15
Beets	1	:	1.30	Apples	1	:	2.20
Spinach	1	:	1.50	Celery	1	:	2.20
Cauliflower	1	:	1.50	Bananas	1	:	2.20
Radishes	1	:	1.70	Figs	1	:	2.30
Chestnuts	1	:	1.80	Cocoanuts	1	:	2.30
Blood	1	:	2.	Oranges	1	:	2.35

Proportion of Organic Sulphur and Phosphorus in Foods
(Continued)

Lettuce	1 : 2.40	Peas	1 : 10.50
Potatoes	1 : 2.60	Beans	1 : 11.40
Grapes	1 : 2.70	Barley	1 : 12.
Pears	1 : 2.70	Oats	1 : 14.
Onions	1 : 2.70	Peanuts	1 : 23.50
Swiss chard	1 : 2.80	Human milk	1 : 24.
Asparagus	1 : 3.	Meat	1 : 27. to 100
Parsnips	1 : 3.	Seafish	1 : 34.
Tomatoes	1 : 3.	Rye	1 : 36.
Grapefruit	1 : 3.30	Haddock	1 : 38.
Strawberries	1 : 3.90	Cottage cheese	1 : 40.
Plums	1 : 4.	Cow's milk	1 : 40. to 90
Apricots	1 : 4.	Corn	1 : 56.
Lemons	1 : 4.	Rice	1 :100.
Almonds	1 : 10.50	Wheat	1 :100.
		Eggs	1 :100.

A cursory reading of this table will reveal the fact that those foods which constitute the bulk of the usual dietary—cereals, pulses, dairy products, meat and fish—are low or entirely deficient in sulphur and comparatively righ in phosphorus; while fruit, and especially green-leaf vegetables, show a far better proportion of these two elements, coming nearer to that of normal blood. The great dietetic and hygienic value of fruits, vegetables and herbs, which consists principally in their comparative richness in the blood-building elements, iron, calcium and sulphur, is not yet fully realized. They are still regarded as mere ornaments or accessories to the ordinary diet with its surplus of meat and farinaceous foods. Moreover, in the average kitchen, vegetables are so irrationally prepared that their beneficial properties are almost entirely lost.

Considering the nutrition of man in the light of above facts, we find an explanation for many diseases which arise from faulty metabolism—diseases which are hardly noticed in the beginning, but which become only too apparent in the course of time; and then years of the strictest hygienic living and self-denial are required to eradicate, or, at least, to alleviate them. It is small wonder that people seek vicarious atonement in patent-medicines, serums and drugs, which promise instant relief.

The excessive use of white flour products in occidental countries as the fundamental cause of abnormal formation of tissues,

cancerous and nervous diseases, asthma, obesity, diabetes, etc., finds its correlative in the more or less exclusive fish and rice diet of the oriental countries, as the source of leprosy, beri-beri, etc. Almost every civilized nation has its characteristic diseases, arising from faulty nutrition. Thus we find gout and rheumatism predominant among the meat-eating northern peoples, white pellagra is found in the southern European countries, chiefly in Italy, where people live on macaroni, maize, cheese and wine.

The polaric distribution of sulphur in plants should also be considered. During their growth this element is carried to the stems, leaves and skins of fruits and seeds, corresponding to the accumulation of sulphur in the skins, sinews, hair and feathers of the animal body. Nature here follows a definite object. Sulphur, like silicon, has a good insulating power which holds the electricity of the body together, preventing its premature and too rapid dissipation, and at the same time giving all those parts of the body containing it, softness, elasticity and pliability.

Sulphur can, of course, exert its beneficial influence only when it is taken in organic form. The inorganic compounds of sulphur, as they are found in mineral waters, or used as preservatives, are always detrimental to the system.

Silicon, or Silicium (Si), is found in nature very abundantly as silicon dioxide or silica (SiO_2) in the form of rock-crystal, quartz, agate, sand, etc. It exists also in the form of silicates, which are silicic acid in which the hydrogen has been replaced by metals. Most of our common rocks, such as granite, porphyry, basalt, feldspar, mica, etc., are such silicates or a mixture of them. Small quantities of silica are found in spring waters, as well as in vegetable and animal substances. Silicon resembles carbon both in physical and chemical properties, and belongs to the same group of elements. (See Mendeleeff's periodic table.) In its elementary state it forms steel-gray octahedrons with a specific weight of 2.5.

In the organic world silica is most effective as a protective agent against chemical disintegration and putrefaction. The element has, therefore, a strong antiseptic action, being a safeguard against epidemic diseases. The mineral matter from healthy muscular tissues contains at least two per cent silica, which is also found to a considerable extent in hair, feathers, nails and claws. In vegetable foods the silica is combined with cellulose, and forms the

skin of fruits and vegetables and the outer coats of cereals. In white flour, also cornmeal, polished rice, etc., this coat has been removed in the form of bran. This deficiency of silica gives rise to many diseased conditions and makes the system easily susceptible to injurious influences. Silica, being a good insulator, warms the blood by insulating and keeping together the electricity imparted through its salty constituents. Silicon is found particularly in the connective tissue. As nerve substance contains nearly the same amount of silica as the albumen in the blood, this element forms, as it were, a connecting link between blood and nerves, preserving their proper relations. Many diseases of the blood and nervous system may be traced to a lack of silica in the food.

The pancreas is especially rich in this element, its mineral constituents showing about twelve per cent of silica. It is found combined with fluorine in the enamel of the teeth. Human hair shows from 0.10 to 0.23 per cent of silica. Hair needs for its growth both silica and sulphur. If they are not given in sufficient quantities to the blood, the hair cannot be nourished properly and falls out. The skin, and likewise the walls of all cells, contain a considerable amount of silica, which has been placed there by nature to prevent a too rapid radiation of the body's heat and electricity. We, therefore, see that silicon, like the other elements, has certain physiological functions to perform, which makes its presence in our food and, consequently, in the different parts and organs, indispensable. The amount of silicon in the body may be small, compared with other elements, but its importance as an essential building element of the body should never be overlooked. The origin of so-called infectious diseases must be largely attributed to a deficiency of this element in the system, as the average diet of man usually lacks silica. The ash, for instance, of the outer coats of the rice kernel contains about eighty per cent of silica, which is to a large extent lost by the peeling, and, further, by the polishing process. In the same manner silica is lost in the artificial preparation of all cereal foods. In peeling fruit we also lose an appreciable amount of organic salts. Wherever it is possible, fruits should be eaten with the skin which must, of course, be properly masticated.

Chemical analysis shows that very valuable elements are contained in all skins of cereals, fruits and vegetables. As an in-

stance of the great difference to the health resulting from the use or rejection of the skins, an incident may be given that occurred in India, as told by an Indian officer.

A regiment was stationed in a part of the country where grapes were the chief article of food. The officers, one after another, became so sick that they were unfit for service. Since, at the same time, the remarkable fact was noticed that the troops were all well, a commission of inquiry was instituted. It was found that while every trooper in eating the grapes swallowed the skins, the officers followed the fashionable habit of rejecting them. The officers were then ordered to masticate and swallow the skins. This was done, and they quickly recovered.

Chlorine is chiefly found in sodium chloride or common salt ($NaCl$), either dissolved in water (small quantities in almost all spring water, larger quantities in some mineral waters, and the greatest amount in sea-water), or as solid deposits in the interior of the earth as rock salt. It may be isolated by chemical processes, when it appears as a yellowish-green gas, having a disagreeable taste and an extremely penetrating and suffocating odor, acting energetically upon the air passages, producing violent coughing and inflammation. Chlorine is about two and a half times heavier than air and is soluble in water. There are but few elements which have as strong an affinity for other elements as chlorine. The act of combination between chlorine and other elements is frequently attended by the evolution of so much heat, that light is produced, —or, in other words, combustion takes place.

In the vegetable kingdom chlorine occurs mostly in the form of potassium chloride and sodium chloride. Small quantities of sodium chloride applied to the soil have a beneficial action on various crops, and, to an extent, increase their resistance to drought and rust fungi. When the amount of sodium chloride reaches a certain degree of concentration in the soil, however, injurious effects will be observed. A solution of 1.8 per cent sodium chloride will prevent the germination of wheat. The assimilative process in the leaves is also retarded by a surplus of sodium chloride in the soil. Other injurious effects are the decrease of sugar in the sugar beet, and of starch in the potato. An over-supply of potassium and magnesium chlorides also depresses the starch content of the potato.

Chlorine, in the form of sodium chloride, plays an important part in the animal organism. It assists in the formation of all the digestive juices, principally the gastric juice, which contains two per mille hydrochloric acid. The mineral matter of the blood serum is largely made up of sodium chloride which favors and sustains the generation and conduction of electric currents. About one-third of the ash of the white of hen's eggs consists of sodium chloride. Milk also contains a large amount of chlorine, which perhaps may be explained by the fact that the chlorides are useful, not only in the construction of the organs but also in the preparation of the digestive secretions.

Chlorides are likewise important for renal secretion. They are necessary for the elimination of the nitrogenous products of metabolism. This is shown by the fact, among others, that diuretics also increase the excretion of chlorine. The fact that sodium chloride is a normal constituent of the human body, being present to the extent of 6.5 per mille in the blood, has given it special importance in the eyes of the people, and has lent credence to many exaggerated popular notions regarding its curative effects. Whenever the inorganic salt is ingested, it draws fluid from the tissues rapidly and there results an increased discharge of urine, greatly exceeding the quantity of water ingested. This produces the sensation of thirst which leads to the excessive imbibing of liquids and consequent weakening of the kidneys. The inorganic salt also diminishes the secretion of hydrochloric acid, causes peptones to become deficient, and disturbs the absorption of sugar.

Chloride of sodium added to food is not, in any case, essential to health, but is treated simply as a foreign body, the system being able to utilize as food only the chloride which exists as organic combinations in food stuffs. The amount of sodium chloride contained in a natural form in vegetables and fruits is quite sufficient for our needs.

A table giving the amount of chloride in various food products will be found in the appendix of this book.

Fluorine exists chiefly in nature as fluorspar and calcium fluoride (CaF_2). Traces of fluorine occur in many minerals, in some waters, and also in the bones of mammals and in the enamel of the teeth. Fluorine was scarcely known until 1887 in the elementary state, because all attempts to isolate it were frustrated

by the powerful affinities which this element possesses, and which render it difficult to obtain any material for the manufacture of a vessel which is not chemically acted upon, and therefore destroyed by fluorine. The method now used for liberating fluorine depends upon the decomposition of hydrofluoric acid by a strong current of electricity in an apparatus constructed of platinum with stoppers of fluorspar. To prevent a too rapid corrosion of the platinum vessels, the decomposition is accomplished at a temperature below the freezing point. Fluorine is a gas of yellowish-color, having a highly irritating and suffocating odor, and possessing affinities stronger than those of any other element.

Fluorine exists in small quantities in nearly all plants and animals. It is chiefly found as fluorid of calcium in the bones of teeth of men and mammals, but the exact amount has not yet been ascertained. It has also been detected in the blood of birds and mammals, as well as in the yolk of eggs and in milk, also in the outer coats of grains.

We must, therefore, conclude that it is an essential element of the organism. It assists in building the enamel of the teeth, and is needed in the development of the skeleton, as no normal bony substance can be formed without fluorine. The iris of the eye, which reflects the whole organism, also requires fluorine. A deficiency of the element in the lens of the iris is followed by ophthalmic diseases. The artificial preparation of our food stuffs by which the greater part of the fluoride of calcium is removed or made inert, also the inadequate supply of this substance to the soil, is one of the principal causes of premature decay of the teeth, curvature of the spine, and early weakening of the eyesight.

Iodine is a non-metallic element, found in small quantities in many plants and animals. In its free state the element is soluble in ether and alcohol, but only slightly in water. It possesses an acrid burning taste, and a neutral reaction. According to the degree of the application, it stains the skin yellow, brown or black, and its action is painless, provided the skin is intact. Upon mucous membranes iodine acts as a powerful irritant. Taken as a drug it escapes chiefly through the kidneys, the skin and the salivary glands.

Very little is known yet about the action of organic iodine upon

the physiological functions, but it seems to be a natural stimulant to the nutritive processes of the body and the circulatory system.

The element is present in the thyroid gland to the extent of about two per mille of the dried weight of the gland, or about ten to fifteen milligrams in the entire gland. It is essential for the formation of an organic iodine compound—thyrosin—which regulates some of the metabolic functions of the organism. A lack of iodine prevents the formation of thyroxin and causes enlargement of the thyroid gland, or goitre. This disease is common in certain districts of the European Alps and the Rocky Mountains. It is probably caused by an insufficient and one-sided diet, and a lack of iodine in the soil. As sea water contains iodine, it is naturally present in all sea plants, such as alga, kelp, Irish moss, etc.

According to Dr. Bouriet, a French chemist, iodine occurs in small quantities in the following vegetable and animal products:

Iodine in 1000 Parts of Fresh Substance

Asparagus	0.240	Potatoes	0.010
Garlic	0.210	Leeks	0.120
Pineapple	0.310	Pears	0.017
Carrots	0.134	Grapes	0.010
Mushrooms	0.172	Rice	0.170
Cabbage	0.210	Lettuce	0.012
Strawberries	0.170	Tomatoes	0.023
Green kidney beans	0.320	Artichokes	0.017
Dry white beans	0.014	Oat flour	0.009
Green peas	0.080	Wheat flour	0.007
Sorrel	0.120	White bread	0.000

Fruits and foods very rich in starch contain but little iodine. According to the same author, foods of animal origin contain the following amounts of this element in 1000 parts of fresh substance.

Eel	0.80	Oyster	1.37
Anchovy	0.95	Lobster	1.78
Grey shrimp	5.91	Whiting	0.31
Crab	1.82	Fresh cod	1.23
Roach	1.38	Fresh salmon	1.40
Smoked herring	1.57	Trout	0.08

Another element, *bromine*, often accompanies iodine, but it is not known as yet whether it performs any definite physiological functions in the body.

Arsenic, which exists in the earth as sulphide of arsenic, is found in minute traces in animals and vegetables. Until recently it has not been considered essential to their well-being. The French chemist, Bertrand, however, as a result of numerous experiments, has arrived at the conclusion that arsenic, instead of being a constituent of a few tissues only, is a constant element of the living cell. He finds arsenic present in the eggs of all fowls, in exceedingly small quantities, the yolks generally containing twice as much as the white.

In 1900 Dr. Gautier, of Paris, established the fact that arsenic in a very small proportion enters into the constitution of the outer tissues, the epiderm, hair, nails, thyroid gland, brain and breast. There are some very small traces of it in other parts of the body. Arsenic appears to resemble in its chemical affinities those of phosphorus.

Copper exists in the earth in metallic form, and enters into the composition of many vegetable and animal tissues, although the quantity is very small and it is not yet known whether its presence has any special significance.

CHAPTER XIV

The Vitamins

The word vitamin is derived from the Latin word *vita,* meaning "life," and *amins* or amino acids, which are component parts of protoplasm. A free translation of the word would be "life substances," or complex organic compounds, upon which the growth and perpetuation of plants and animals depend. Their presence was first discovered by Casimir Funk in 1912, and their effect upon growth has been especially studied by Osborne and Mendel, and McCollum and Davis. Like the enzymes they seem to be composed principally of carbon, hydrogen, oxygen and nitrogen, but their atomic and molecular construction is not yet understood.

According to our present knowledge only plant life can synthesize or build up vitamins out of simpler combinations. We must emphasize the fact, however, that vitamins cannot perform their functions if the food products are deficient in the organic salts necessary for organic growth. In other words, they must be chemically united with other food substances in such organic compounds as we find in wholesome, natural foods. *The chemical and biological actions of the vitamins must always be studied in close connection with those of the organic salts, if we would gain any clear understanding of the problems of nutrition.*

So far three distinctive vitamins have been discovered:

Fat soluble "A" or anti-rachitic vitamin
Water soluble "B" or anti-beriberi vitamin
Water soluble "C" or anti-scorbutic vitamin

Dr. Herbert Evans and Dr. K. Scott Bishop, of the University of California, claim to have discovered another vitamin called "X," which exists in lettuce, alfalfa and egg yolk and will probably take its place as the fourth established vitamin. There are probably many more vitamins in natural food but until the discovery of vitamin "X," only three had been commonly demonstrated and accepted.

Two vitamins "D" have also been announced recently. Dr. E. V. McCollum has so designated an anti-rachitic factor which is different from vitamin "A." Casimir Funk gave the letter "D" to another vitamin that yeast contains in addition to "B." This second yeast vitamin does not seem to play a part in mammalian physiology. Neither of these vitamins is fully accepted as yet and it seems probable that the dietary factor "X" will be considered the fourth established vitamin.

Vitamin "A" is found mostly in the green leaves of plants, such as spinach, lettuce, cabbage, alfalfa, clover, etc.; in tomatoes, carrots, sweet potatoes, yellow corn, green peas, etc.; also in butter-fat, egg yolk, palm oil, cod liver oil, in liver and kidney tissues and glandular organs in general. The solids of spinach and tomatoes contain more of vitamin "A" than butter-fat. It is essential to the normal growth of the child, or the young of animals, and a deficiency of it will produce stunted growth, emaciation and rachitic conditions.

Vitamin "B" is contained principally in plant foods, the seeds of cereals, peas, beans and other legumes in their natural state, and when not impoverished by modern milling processes. Citrus fruits furnish a considerable amount of vitamin "B," more than do the deciduous fruits. Nuts contain a considerable quantity, and, like vitamin "A," it is also found in the green leaf vegetables. An insufficient supply of the vitamin "B," as for instance in a diet consisting largely of peeled or polished rice, results often in a specific nervous disease known as beri-beri. In order to maintain health in young and old, a constant supply of "B" is required.

Vitamin "C" is present in largest amounts in fresh fruits; to a less extent in raw vegetables and tubers; in moderately small quantities in milk and meat. Among fruits the best sources are oranges and lemons; among the vegetables, various turnips, carrots, rhubarb and tomatoes. Baked potatoes contain moderate quantities. An absence or insufficient supply of vitamin "C" produces scurvy.

Of the three vitamins, "C" seems to be the least stable and is easily affected by heating. A liberal amount of fresh fruits and vegetables, therefore, is always necessary to maintain health. Sufficient quantities of vitamin "A" may be obtained from steamed vegetables in which all the organic salts are preserved.

"B" occupies an intermediate position, and while raw cereals cannot be recommended as ideal food for man, they should at least be used in their natural form, such as whole rice, whole barley, whole wheat bread, whole corn meal, etc.

According to the *Daily Science News Bulletin,* in experiments which have been made with rats, the *Vitamin X* does not seem to affect the growth of the individual rat, but its lack does prevent the mother rat from having offspring. Drs. Evans and Bishop have found that rats reared on the ordinary "purified" laboratory diet, consisting of casein, cornstarch and lard, with a little butter-fat and salts, even when given ample quantities of the growth-producing vitamins A and B, are sterile without exception. To quote from the bulletin (the italics are mine):

"'*It is startling to observe that fat, slick-coated rats fed on this diet are sterile, but that when they are fed fresh green leaves of lettuce they immediately are able to produce full and normal litters of young,*' explained Dr. Evans here today where he is conferring with officials of the U. S. Bureau of Animal industry on details of his work in cooperation with governmental dairy experts.

"The experiments that demonstrated this new factor in food were carefully carried out so as to eliminate the possibility that the non-productiveness of the rats had any other cause. In most cases sister rats from the same litter were used. The one fed on the laboratory diet without lettuce remained consistently sterile, while the one that received the lettuce ration was always productive. By switching the diet, the opposite results could be obtained.

"The government experts in animal husbandry at the Department of Agriculture here are extremely interested in Dr. Evans' results and they believe that factor X may explain cases of infertility in cattle that have puzzled them in the past. Experiments at the Beltsville, Md., experimental farm are planned."

Anybody with a thorough understanding of the problem of nutrition knows that all animals, if fed on denatured foods in which the elements essential for growth are lacking, will lose their fecundity, just as carnivorous animals do in captivity, if fed mostly on lean meat, for the necessary organic salts are contained in the blood, bones and entrails. That the rats recovered rapidly, if given green leaf vegetables, rich in sodium, calcium, magnesium and iron, the principal bone and blood building elements, confirms the vital importance of these foods in building a strong and healthy body, a fact which has long been known by students of dietetics.

We cannot extract vitamins. Even if it were possible to do so, we cannot utilize them separately as body-building material, any more than we can dissolve an apple into its inorganic elements and try to live on them. Vitamins, as already stated, are active only when they exist in combination with other elements in natural food.

The vitamins themselves supply the body with neither energy nor tissue building substances. They enable the body to utilize the energy-producing components of our foods, and, if offered in an organic form, regulate the assimilation of the tissue-building elements. They are active in extremely minute quantities, and, in that respect, they resemble the enzymes in their catalytic actions, producing chemical changes without undergoing any change whatever in themselves.

The vitamins, to be sure, are indispensable in the process of nutrition and growth in the vegetable, as well as the animal kingdom. But far more important than the vitamins are the mineral elements, or organic salts, in our food, especially in their relation to each other in the normal growth of the body, and in the performance of the various physiological functions of the organism, and, last but not least, in the preservation of its health and power of resistance to injurious influences.

The vitamins have furnished the medical profession with a clue, whereby they can gradually work towards a more sensible and natural method of nutrition and prevention of disease, as evidenced by numerous magazine articles and books, which have recently appeared. It is regrettable, however, that commercialism is taking undue advantage of this situation and is now exploiting the vitamin theory. "Specially prepared" vitamin foods, mostly in the form of tablets, also different kinds of yeast, are being widely circulated, claiming miraculous effects, and seem to find a ready sale to a credulous, misinformed public.

Drs. McCollum and Simmonds have recently investigated a number of such commercial preparations, in regard to their alleged potency as sources of water soluble "B" or vitamin "B," the anti-beri-beri, or anti-neurotic vitamin. Concerning the labels they make the following statement:

"An examination of the labels on the containers of the vitamin preparations which we have studied, suggests at once that their promotion for therapeutic purposes represents a repetition of the

'patent medicine' propaganda which has for so long been inflicted on the American public. Thus, the same general symptoms have been used in labels of sarsaparillas, blood-purifiers, kidney remedies, remedies for female weaknesses, etc., reappear as conditions for which the vitamin preparations are said to be specific remedies.

"The claims set forth on the labels, of the medicinal values of these preparations, are extravagant and misleading. They do not contain the vitamin 'B' in concentrated form, as they are represented to do. The marketing of these preparations represents an attempt, and, unfortunately, a successful one, to substitute a commercial vitamin propaganda for the nefarious patent medicine business."

Dr. Casimir Funk, discoverer of the vitamins, when recently interviewed, also expressed the opinion that the American public would do well to curb its tendency towards making a fad out of the practical application of vitamins to daily routine. He said in part:

"Science is very much in the dark yet as to the composition and functions of vitamin. The combined research has taught us that all we do know about the subject is of tremendous importance. But it is not detracting from the valuable place that vitamins hold in the list of food elements to say that we are just beginning to understand them a little.

"Reputable scientists do not countenance the efforts that are being made to deceive the public into believing that the time has come when it can be said satisfactorily that such and such a result will follow the practice of taking certain proprietary vitamin preparations.

"To put it briefly, the people who are promoting such preparations do not know what they are talking about. And they certainly are leading the public into deception. If their claims for these products could be substantiated, science would greet them with open arms. There are several hundred scientists experimenting, but, as yet, vitamins have not been isolated, much less concentrated.

"Besides, vitamins so far have proved of value only where there have been cases of very distinct vitamin deficiency. When the diet is complete, we do not know yet whether an additional supply of vitamins is needed or even advisable. No one has established the quantity of vitamins necessary for maintenance of the average healthy person.

"There is nothing mysterious about vitamins. They are just food constituents that should be in our diet, just as other food properties should be found there too.

"I do not know what use, practical or otherwise, will be

made of isolated vitamins when we have succeeded in separating them. I could not even venture a guess—no one can know. I confidently predict that the time will come eventually when we shall succeed in such isolation. But no one has succeeded in doing it yet.

"*What would be the use in preparing all our foods artificially, so long as Nature is producing her own foods in sufficient abundance to supply an increasing population? It would be folly even to think of turning ourselves into domestic manufacturers and consumers of self-made food so long as Nature gives us enough.*" (The italics are mine.)

In regard to milk Dr. Funk said:

"The contents of vitamins in milk have been greatly exaggerated. There are other foods that are far richer in vitamin content than is milk. We are by no means dependent upon milk alone for our supply of vitamins.

"The vitamin content in both mother's and cow's milk is essential for infants. But vitamins are not any magical possession of either milk. They exist only because the mother or the cow has assembled them from the food she has eaten prior to production of the milk."

It is evident that the quality of mother's milk, or that of any animal, depends largely upon the quality of food consumed. If the food is impoverished, naturally the milk cannot supply the necessary elements for growth. We cannot recommend cow's milk unqualifiedly without knowing how the animals were fed.

After all it is reasonable to assume that nature has built the vitamins principally for the growth and perpetuation of plant life itself. Without the vegetable kingdom, the great store house of potential energy, stored up by the sunlight, the animal kingdom could not exist. The vitamins in the seeds serve primarily for the germination and development of the seed into the embryo plant, while the vitamins in the roots and fruits all have their special physiological functions to perform. In the nutrition of man and the animal the vitamins are only of secondary importance.

The chemistry of life is very complex, and in order to come to a deeper understanding of it, we have to consider all of the elements in their chemical affinities and reactions, their polarization in the different parts of the plant, and again in the animal body, especially during the period of growth. The discovery of the vitamins, important as it is, can never furnish us with a sat-

isfactory explanation of all the wonderful phenomena of organic life. It is only one link in the chain of the science of nutrition.

In discussing the vitamins, let us always remember these great and outstanding facts: the human race has survived in the struggle for existence for millions of years, developing its superior mental and physical qualities, while subsisting on natural foods, such as nature in her infinite wisdom had prepared, unblemished by the hand of man. On the other hand, flour and rice mills, sugar refineries, slaughter houses, and especially elaborate cookery, all characteristic features of modern civilization—are constantly turning out devitalized and demineralized foods, with the result that our standard of health has been lowered to an appalling degree.

Nearly every year a new discovery in physics or chemistry is heralded as a panacea for all evils to a suffering humanity. A few years ago it was radium, and now it is vitamins. There is only one way to secure your daily ration of vitamins. Eat simple, natural foods, chiefly fruits and green leaf vegetables, with a few nuts, or whole grain products, and you will be well nourished, without the addition of yeast cakes or vitamin tablets.

CHAPTER XV

The Soil and Its Relation to Food and Health

As all our food comes directly or indirectly from the soil, the fact should be emphasized that the chemical composition of the soil is a most important factor in the production of a healthy vegetation. What has been said about mineral elements in relation to the human body, holds equally true in the case of plants and trees. These often suffer from the want or excess of proper minerals in the soil, which naturally results in poor crops and diseased conditions. We should learn to recognize the fact that the soil must contain all the essential constituents of plant life in an assimilable form, in order to produce a normal plant containing all the required elements in the right proportion; and that man is, therefore, absolutely dependent on the soil to produce such foods as give him the best health and the greatest power of resistance.

The present systems of fertilization are still governed by many erroneous ideas. The German scientist Hensel was one of the first to point out the mistakes made in agriculture. A considerable quantity of phosphoric acid and of potash is found in the ashes of all seeds. As these do not exist in the air and must, therefore, be furnished by the soil, it was natural that the teachers of agriculture announced that potash and phosphoric acid, including nitrogen, are the most essential fertilizers, and the more phosphoric acid the better. But this conclusion is erroneous and has caused much injury. The fact was overlooked that, during the time of vegetation, phosphoric acid is so uniformly distributed that it does not amount, on the average, to more than one-tenth of the total mineral constituents. The peculiarity that phosphoric acid, during the process of ripening, accumulates in the seeds to such an extent that it constitutes not merely ten, but from thirty to fifty per cent of the total mineral matter, is explained by the fact that the phosphorus passes from the stems, stalks and leaves into the seeds, leaving the straw very poor in phosphoric acid. Taking the average of seventy to eighty analyses of German field crops, which also include the roots, stems and leaves, we find that phosphoric acid constitutes about one-tenth

of the mineral constituents; while potash, soda, lime, magnesia, iron, silica, sulphuric acid, chlorine and fluorine, constitute the remaining nine-tenths. Furthermore, potash and soda are present on the average in the same amount of weight as lime and magnesia, these four bases amounting to about eight-tenths of the whole quantity of ashes.

According to these facts a fertilizer which would satisfy the natural demand of supplying the minerals necessary for the development of plants should contain eight parts of potash, soda, lime and magnesia to one part of phosphoric acid. These mineral bases are found in every primitive rock and when perfectly decomposed and judiciously mixed with humus, make ideal fertilizers. In Germany an increasing number of farmers are experimenting successfully with this new method of fertilizing which will be appreciated more and more and gradually supersede the old methods. The common commercial fertilizers and manures supply plants with too much forcing material and too much phosphoric acid, substances which favor the propagations of all kinds of injurious insects. Vegetables and fruits grown on a soil treated chiefly with manure may be larger, on account of the over-supply of ammoniacal compounds, which have the tendency to draw water, but they are deficient in the important minerals which give firmness and consistency to the tissues and prevent them from prematurely decaying. When the early agriculturists established their theories of fertilization on the mineral constituents of seeds with their high contents of phosphorus, potash and nitrogen, they did not consider that the different parts of the plant require different proportions of elements than those which are found in the seeds alone. Hensel saw what some day all the world will see, viz., that plants require a certain well-proportioned quantity of all the necessary mineral elements for their healthy growth, just as much as man and animals do; that insufficiently or wrongly nourished plants, like animals, fall a prey to diseases more quickly than those specimens which are well built, as a result of an adequate supply of the essential organic salts.

Hensel's views on the proper feeding of plants invite a comparison with the usual methods of human nutrition which are still advocated by the majority of the medical practitioners, who concern themselves very little with real prevention of disease. Neu-

rasthenics and consumptives are advised to eat heartily of meat, eggs and other protein foods which easily enter the circulation but overload the system with nitrogen and phosphate of potash, which still further increase the acidity of the blood. The consequence is an increased stimulation of the nervous system and irritation of the whole organism. This irritation, which is mistaken for an improvement, soon leads to complete exhaustion and debility.

That nitrogenous foods are strengthening is a grave error full of fatal consequences for the nutrition of the plants as well as of animals and men. The constantly increasing number of diseases is largely the result of impoverished foods raised on impoverished soil. Germs and microbes are the effect and not the cause of this deplorable condition. They cannot live and propagate on sound and healthy tissues, any more than a crop of wheat can be raised on a solid granite rock. Man is learning slowly and pays for his deviation from the laws of health and right living by disease and needless suffering.

Sixty years ago Baron von Liebig wrote in his work "Natural Laws of Husbandry," with the characteristic, penetrating thought of genius:

"No intelligent man who contemplates the state of agriculture with an unbiased mind, can remain in doubt, even for a moment, as to the stage which husbandry has reached in Europe. We find that all countries and regions of the earth, where man has omitted to restore to the land the conditions of its continued fertility, after having attained the culminating period of the greatest density of population, fall into a state of barrenness and desolation. Historians are wont to attribute the decay of nations to political events and social causes. These may, indeed, have greatly contributed to the result; but we may well ask whether some far deeper cause, not so easily recognized by historians, has not produced decay and downfall of nations, and whether most of the exterminating wars between different races may not have sprung from the inexorable law of self-preservation. It may seem to the superficial observer that nations, like men, pass from youth to age, and then die out; but if we look at the matter a little more closely, we shall find that, as the conditions for the continuance of the human race which nature has placed in the ground, are very limited and readily exhausted, the nations that have disappeared from the earth have dug their own graves by not knowing how to preserve these conditions. Nations like China and Japan which know how to preserve these conditions of life have not died out.

"Not the fertility of the earth, but the duration of that fertility, lies within the power of the human will."

In regard to nitrogenous manures the same scientist says:

"Upon a field excessively rich in nitrogenous food there is a kind of rankness in the early growth like that produced by a hot-bed; the leaves and stalks are weak and watery, because of the want of time in their over-hasty growth to absorb simultaneously from the soil the necessary quantity of substances, such as silicic acid and lime, capable of communicating to their organs a certain solidity and power of resistance against those external causes which endanger their existence. The stalks fail to acquire the necessary stiffness and strength, and are always liable to be laid, especially upon lime soils.

"This injurious influence of an excess of nitrogenous food is particularly remarkable in the case of the potato plant; for if it grows upon a soil excessively rich in nitrogenous food, and the temperature should suddenly fall and wet weather supervene, the plant is often attacked by the so-called potato-disease; while a neighboring potato field merely manured with ashes shows no trace of it.

"Many thousand farmers who have not the remotest conception of manures, apply guano, nitrates, and other fertilizers to their fields with fully the same effect and with even the same skill as others who possess such information; nor do the latter derive any manifest advantage from their knowledge, because it is not of the right kind. For example, the chemical analysis of manures is rather calculated to ascertain their purity, and to determine their price, than as a means for making us acquainted with their effect upon the land."

Professor Frank M. Keith of Medford, Massachusetts, who has made many investigations in regard to deterioration of the soil and the increase of plant diseases, comes to the same conclusion as Dr. Julius Hensel of Germany. In a highly interesting and instructive article, which appeared some time ago in the Sunday Herald, Boston, Mass., Professor Keith said in part:

"For many years the agriculturist has been confronted with the problem of just why his crops do not increase even though he has used unlimited supplies of manures and fertilizers. In most cases he does not get anywhere near the crops that had been taken from the same land twenty or thirty years before.

"Just why this condition should exist the farmer can't explain, and in many cases is so thick-headed he won't listen to those who would be only too glad to help him out.

"When the virgin soil was tilled by the early settlers, no manure or fertilizers were used at all, and large crops were pro-

duced. Why? Because the conditions were as nature had made them and had not been disturbed. It is a scientific fact that when vegetables, etc., have been growing for years on the same soil, those vegetables have continually sapped the soil of a large percentage of available minerals. No amount of manures or commercial (three part) fertilizers can possibly restore the soil to anywhere near its virginal condition, because they do not contain the ten minerals necessary to plant life in sufficient quantities to sustain life."

We have been taught for years by some of the most learned professors in many of our state agricultural colleges that the three elements necessary to be added to the soil to produce maximum crops are nitrogen, potash, and phosphoric acid, the proportions varying according to the crop to be grown. And because of these teachings, our farm crops are on the decrease and will continue to decrease until such a time as those professors wake up from years of purely theoretic reasoning and begin to work along practical lines, or when the farmer will take the initiative himself without the assistance of the agricultural college.

For a long time potash was declared to be one of the most essential ingredients of all commercial fertilizers. Until the World War we were told that to grow crops without the constant use of additional potash was impossible. But when the war started and potash was not obtainable from abroad, we were informed that just as good crops could be grown without its addition to the soil. This last fact should have been discovered years ago.

The agricultural chemist shows us that the ashes of all vegetables and plants contain potash, iron, sulphur, magnesia, lime, manganese, phosphorus, silicon, soda and chlorine, and that the plants cannot be grown to perfection with the omission of any one of these elements. If this is so—and we know it is—how did the plants get these minerals? Surely not from the air. They must, then, have been obtained from the soil. But the question naturally arises as to how these minerals could possibly be absorbed by the plant.

There are in the soil, provided plenty of humus (disintegrated vegetable matter) is present, humin and humic acids which, with the heat, moisture, freezing, and thawing, cause an erosion in the small stone particles of the soil, which have gradually been liberated, thereby making them available for plant food. When the

different minerals are liberated and come in contact with the humus and humic acids, there are very minute bacteria being bred, and it is these that change the minerals into a liquid substance which can be taken up by the plant. To the unthinking, happy-go-lucky farmer this statement will seem almost unbelievable. But it is self-evident to those who have been making a careful study of plant conditions and are anxious to know everything possible about the normal development of plant life.

Some agriculturists who have experimented successfully with certain methods of mineral fertilization when confronted by statements of so-called scientific investigators have not, except in a very few cases, had the courage of their convictions, and have given up their claims, despairing of ever putting them into practical operation.

There has been great waste of time and effort in the name of science to determine the available plant foods in soils. The assumption has been that plant foods in soils are of two distinct kinds, "available" and "unavailable," and that the determination of "unavailable" plant food would show not only the crop producing power, but the fundamental fertilizer needed to improve the soil so that it could produce crops.

The question should not be "How much is available?" but rather "How much can be made available during the season?" Or, to put it even more plainly, we must make plant food available by practical and not theoretical methods of liberation, by converting insoluble compounds into soluble compounds, which are accessible to the growing plants. Our Federal Bureau of Soils of the Department of Agriculture at Washington in 1908 made the following statement, which was met by considerable opposition and criticism: "The soil is the one indestructible immutable asset of the nation. It is the one resource that cannot be exhausted, that cannot be used up. It may be impaired by abuse, but not destroyed."

Some of our greatest scientists firmly believe that soils do not wear out. On the other hand, our agricultural colleges, not all, but many of them, teach the theory that soils do wear out. The old theories regarding infertility have arisen from the fact that sufficient minerals have not been available in ordinary soils. Not until the Federated Bureau of Soils took up the study in a sys-

tematic manner, and established the fact that organic matter is quite as important as minerals, was this known; but fertilizers too rich in nitrogen and acids, such as stable manure, are injurious to the plant, and, consequently, to men and animals. Nitrogen, potash, phosphoric acid act only as stimulants, producing quick and rank growth, wholly lacking in strength and stability.

Mineral, or finely pulverized rock, may work more slowly than some of the widely advertised nitrogen stimulants, but it works surely and the soil is improved by its use.

When some great modern chemist commits a stupendous blunder, his erroneous conclusions are heralded throughout the world and accepted as gospel truth. The French chemist Boussingoult, for instance, evolved the theory that plants required a supply of nitrogen in the soil and thousands of agricultural scientists have ever since repeated the same error and induced farmers to buy millions of dollars worth of fertilizers containing nitrogen compounds. The "learned" agriculturists contend, moreover, that plants require an additional supply of phosphoric acid. These "scientists" forget, however, that the required supply of phosphoric acid is already stored in the roots, stalks, and leaves before the grain ripens, and that it is conveyed to the kernels during the ripening process of the grain.

Plants require very little phosphoric acid, and any excess is more injurious than beneficial. The practice of excessive potash, phosphoric acid, and nitrogen fertilization has caused cattle and human beings to become victims of disease. Systematically, although not knowingly and intentionally, they have prepared the way for the spreading of influenza, diphtheria, cancer, diabetes, consumption, typhoid fever, anthrax, glanders, cattle plague, foot and mouth diseases, rinderpest, etc., with the result that America is at the present time paying to its chemical "scientists" more than $600,000,000 for poisonous drugs for human beings, over $100,000,000 for equally injurious concoctions for their cattle, and more than $300,000,000 for doctoring the soil with fertilizers which cannot produce sound and wholesome products.

In Europe agricultural "scientists" recommended fertilizing vineyards with stable manure. Shortly after that the phylloxera made its appearance and destroyed innumerable vines. Then the "scientists" made millions by selling spray to destroy the pests.

Irrational, incomplete fertilization with commercial fertilizers, overloaded with phosphates, or with manure, which likewise abounds in phosphoric acid, is the cause of insect pests such as pin worms, the caterpillars of the conchylis ambiguella, as well as the peronospora viticola. Phosphates are a vital necessity for the propagation of all parasites. Tests made with fungilice and worms show that the residue of their bodies after combustion consists almost entirely of phosphate of potash, but contains only traces of sulphates. This leads to the conclusion that an increase in phosphates means an increase in parasites, while sulphur in combination with other important minerals will check all parasite life.

Curiously enough, our agricultural teachers consider this abundance of nitrogen the most essential factor in ascertaining the value of manure as a fertilizer. They are, however, completely deluded, though it is true that the ammonia contained in stable manure causes a luxurious vegetation, thus making it apparently a substitute for lime, carbonate of soda, calcareous earth and sulphate of soda, insofar as it frequently produces the same growth as these mineral salts. Such vegetables and fruits, however, will decay quickly. Intelligent fertilization will prevent the loss of many millions of dollars' worth of vegetables and fruits.

Stable manure is detrimental to the keeping quality of the soil's products, because it is not a polarically unified combination. Mineral fertilizers are beneficial, because they produce a unified mineral soil which will bring forth sound, wholesome crops. It is a well known fact that ashes possess disinfecting properties and will to a certain extent neutralize manure or any foul, ill-smelling matter. Volcanic ashes in their most powerful combination will produce vigorous plant growth, and, indirectly, strong and healthy people. Vegetables and fruits grown in such a soil will make pure alkaline blood in animals and men.

These statements are corroborated by Sampson Morgan, another pioneer of sane agriculture, of Tenterden, Kent, England, who published some interesting and instructive essays on mineral fertilization entitled "Clean Culture" and "The New Soil Science." In 1873 Mr. Morgan made his first experiments in cultivation. He planted medium sized potato seeds on the level ground, covered them up with fine soil, gave the latter a sprinkling of plaster of paris, which contains lime, then covered them with rich

soil and finally obtained a yield of forty tons an acre. The specimens were enormous, and perfectly free from disease. For forty years he has continued his experiments when opportunities presented themselves, enabling him to put "Clean Culture" upon a sound, practical and scientific basis. Mr. Morgan says in part:

"'Clean Culture' is of universal application. It would work wonders in every part of the world. It would in time make all soils healthy, and all people proof against disease.

"Generally, it will assure the creation and development of colossal new industries, through the peaceful and profitable utilization of countless billions of tons of non-stimulating plantfood, at present lying unutilized on every hand.

"I have proved that granite dust, the bon-fire ash of the world-forming conflagration, furnishes all the potash crops need. I have also proved that the millions spent by cultivators upon chemical and 'forcing' plant foods have practically been wasted, besides often causing much harm. I have further proved that many bodily ailments are mainly due to the continued consumption of deficiency foods, produced with manure devoid of the mineral furnished in the primary rocks in a perfect form.

"In 1915 I broke all records for apples and potatoes for the world, thanks to 'Clean Culture.' The apples were grown on a young dwarf tree planted two years and specially pruned. It bore twenty large fruits. They measured on the average fourteen inches in circumference and weighed four ounces, though gathered six weeks before they had finished swelling. This was equal to over 100 bushels per acre within two years of planting. Other trees, in the same experiment plot, two years planted, bore from 30 to 100 fruits each. The potatoes grown on my mound system produced from eighteen to thirty-six potatoes to a root, weighing nine to ten pounds, equal to fifty tons to an acre. The samples were very clean and of good grade. The largest were six inches long, three broad, and weighed from ten to sixteen ounces each. Two boxes of those products exhibited in London and inspected by large crowds were admitted the greatest hit of the season.

"In 1917 I again broke all records in apple production. On one dwarf tree four years planted on a surface space of only eighteen inches by seven, were twenty-two good sized apples, beautifully colored, growing apparently in one cluster. Several of Cox's Orange Pippin trees had from 80 to 120 large, richly colored specimens. An early culinary variety, five feet in height, including the year's new wood-growth, had 250 apples, 150 were thinned out, 40 were used when well grown and the remaining 60, when fully developed, were from 9 to 10 inches in circumference, though none were grown for size. A tree, on a surface space of 17 by 10

inches, showed an unbroken surface of 17 fine apples. It had 60 fruits even within 32 inches of the ground.

"Several of the trees bore 80 half-pound apples each. One produced 90 such. A *Peasgoods Nonsuch*, 4 feet high, bore 26 fruits, each 12 to 13 inches round, weighing on an average of 13 ounces each. The trees, which produced a bushel each, show the possibility of getting apples at the rate from 150, 300 and even 600 bushels an acre from dwarf trees. An Essex grower claims to have got 300 bushels from an acre of cordon trees. I had cordons carrying 30 apples, weighing 7 pounds, at the rate of 600 bushels an acre. Has a bushel of apples from a dwarf tree, four years planted, ever been equalled? I doubt it. I challenge anyone to repeat the performance with a manure-fed tree. Specimens were sent to leading representatives in literary and scientific circles and brought me flattering commendations. Bushel boxes of the record apples were exhibited in six large cities including London.

"In 1918 I broke all records for potatoes with a 500-foot row, digging fine samples at the rate of 65 tons an acre, a success never achieved by any other experimentor.

"When I introduced 'Clean Culture' it was abused by sceptics and parties interested in perpetuating the bad, unscientific old system. But as the result of the magnificent appreciation expressed for it by those who put it to test, the experts, writers in trade magazines, specialists, chemists and scientists are coming round gradually to my views, though they do not commend my work.

"American investigators say there is something in the soil of a deleterious nature which at present they do not understand, but that it is of an organic nature. Clean Culture explains the mystery. The deleterious organic matter is the poisonous soil-souring carbonate of ammonia which is contained in stable manure. I was the first to claim and prove that uncontaminated humus, green manure humus, is vital to the health of the good bacteria, and without it a healthy and productive soil is utterly impossible.

"Until I dealt with the subject of foods and feeding in connection with soil bacteria, no one ever thought about the subject. The greatest experimentalists on the Continent putting it to test, were forced to the conclusion that I was right concerning the true food of the soil bacteria.

"Without the provision of uncontaminated organic matter and ash, the maintenance of fertility is impossible. Clean Culture mineralized humus is the last word that can be said in respect to perfect production, the elaboration of healthy fruitful tissue and permanent fertility.

"The men who introduced condensed extracted chemical food for plants, predicted they would feed man on chemical food. But the wheat and fruit forms still remain."

Dr. H. Lindlahr of Chicago, one of the pioneers of Nature Cure in the United States, gives in his "Vegetarian Cook Book," the following interesting and instructive data:

"In our institutions for the healing of the sick we begin the treatment of patients by treating the soil of our gardens and farm lands with mineral fertilizers. In connection with our Elmhurst Health Resort we have been cultivating sufficient garden and farm land to furnish our institutions from spring to fall with vegetables grown on highly mineralized soil. For many seasons now we have saturated the land with wood ash, sifted coal ash, finely pulverized lime rock, pulverized phosphate rock, iron filings and with small quantities of ground rock salt.

"Wood ash is to the soil what milk is to the human body. It contains all the minerals in the vegetable kingdom in concentrated form and in the right proportions. When any kind of vegetation is burned, all the negative carbonaceous and protein elements are dissipated, while the positive alkaline bases of iron, lime, sodium, potassium, magnesium, manganese, silicon, and also the earthy sulphates and phosphates, remain in the ash.

"Sifted coal ash also is a good mineral fertilizer, though not as valuable as wood ash. Coal originally was vegetable matter which contained minerals in the live organic form. Coal ash is rich in iron, sulphur and silicon.

"Lime rock from Elmhurst quarries, specially pulverized for fertilizing purposes, contains about fifty per cent lime and four other valuable minerals.

"The value of pulverized phosphate rock as a mineral fertilizer is now generally recognized by our agricultural stations. The addition of this fertilizer alone has, in many cases, doubled and trebled the crops from land that was supposed to be completely exhausted.

"Iron filings decompose or rust in the soil and enter into chemical combinations suitable for assimilation by plant life.

"Black loam that has a tendency to acidity can also stand a moderate amount of ground rock salt. Too much of it would burn the tender plant. We have applied to our garden land from two hundred to three hundred pounds per acre.

"The effect of this continued, systematic, mineral fertilizing on the products of our gardens has been little short of marvelous. Every season our vegetable gardens excite the admiration of those who have the pleasure of seeing them.

"During a period of four years we have grown over forty varieties of vegetables and, when the weather was seasonable, with splendid results as regards quantity and quality."

How important it is to pay proper attention to the condition and chemical composition of the soil as the source of our food supply and in determining its quality, could be shown by many striking examples. For instance, it has been found in Victoria (Australia) that cattle on certain pastures develop paralysis and other infirmities which can be cured by proper fertilization of the soil. In the United States in some areas it is impossible to maintain cattle in good condition until the forage is improved by suitable mineral fertilizers, which illustrates the fact that a deficiency of organic salts in plant tissues leads to nutritional disorders in animals, conditions which are often ascribed to infection by germs.

Wrong fertilization and exhaustion of the necessary mineral elements of the soil is probably the cause of many failures in fruit crops and a larger number of nutritional diseases than has been hitherto thought. For years mankind has accepted the idea that fertilizing must be done (to use plain English) with filth—animal, bird or human excrement, reinforced with nitrates and phosphates. But it will be found eventually that despite all such manure, the land is slowly but surely losing its fertility; that insect pests increase, and, what is worse, that the quality of the soil's products is deteriorating. Intelligent soil culture will, therefore, be one of the most important problems with which the growing population of the earth will have to deal, for the health and welfare of nations depends on rational nutrition.

Investigations along these lines are of such vital importance that the government of every civilized country ought to take up the extensive study of the subject. The United States Department of Agriculture has made a large number of analyses of food products, but the specific study of the mineral elements and their relation to each other in the healthy growth of plants and animals has been neglected. All nations are spending vast sums for the constant increase of armies and navies and for instruments of destruction. If they devoted but a hundredth part of this money to the advance of agricultural food chemistry and the science of nutrition, there would soon be no more need for territorial conquests, and a more amiable relationship between the nations would result.

The World War, from whose effects our superficial civilization is still suffering, was nothing but the outcome of our present system of commercialism, which pervades both modern industry and agriculture. Everything is raised or manufactured for quick profits and the accumulation of fortunes, exciting the rivalry of individuals and nations. The quality of the products is sacrificed to the quantity of goods, which must be disposed of at all costs.

In the intelligent and intensive culture of the soil, in the raising of wholesome and durable products, in making the land accessible to all—in rational living, mankind will yet find its salvation from famine, disease and war.

PART II

FOODS: THEIR ORIGIN, NUTRITIVE AND HYGIENIC VALUE

AND

THEIR RELATION TO HEALTH AND DISEASE

CHAPTER I

Man's Natural Diet

Modern science enables us to discover the natural diet for man, first, by revealing his true place in evolutionary processes of nature; secondly, by studying the qualities and chemical compositions of the different articles of food, and their functions and effects in human nutrition.

According to their bodily structure and their natural capacity to provide, digest and assimilate food, comparative anatomy divides the mammalia, to which man belongs, into four distinct classes: the omnivorous, the carnivorous, the herbivorous and the frugivorous. Man's strong resemblance to the anthropoid apes, which subsist mainly on fruits and nuts, places him in the frugivorous class. In fact, all the great anatomists, Sir Charles Bell, Dr. Richard Owen, Dr. William P. Carpenter and Baron Cuvier, have demonstrated that man is not only adapted by anatomical structure to a diet of fruits and nuts, but that man's disregard for the natural law of his being is a source of endless suffering and disease. This fact, which was recognized already by the ancient sages, Plato, Socrates, Pythagoras, Plutarch, Seneca and others, has also been confirmed by the great universal law of evolution, which Lamarck, Darwin, and Haeckel have scientifically established, and which has thrown much light upon the origin of life and its development on our planet.

As early as the beginning of the nineteenth century, the French scientist, Lamarck, by his geological researches came to the momentous conclusion that all the existing species of plants and animals had gradually developed from the lowest and simplest forms to their present complicated organisms; and that immense periods, perhaps many millions of years, had been necessary to effect these great transformations.

Lamarck was the first who clearly showed in his *Zoologie philosophique* that the history of organic life upon our planet is recorded in the sedimentary rocks of its surface, and that the strata of these rocks are the leaves in the great book of nature in

which she unmistakingly reveals her wonderful works of creation. In the different strata of rock we find different fossils or petrifactions of animals and plants, and ascending from the interior to the surface of the earth, we find an almost uninterrupted gradation from the lowest to the highest form of organic life. According to the time in which these changes on the earth's surface took place, the different layers are called primary, secondary, tertiary and quaternary rocks or strata.

The lowest forms of vertebrate animals, the fishes and amphibians, are found in the primary rocks. In the secondary strata appear fossils of reptiles, birds and mammals; in the tertiary strata, nearest to the surface we find remains of the higher organized mammals. While in the quaternary strata appear the traces of more modern forms of life.

Between the development of animal and plant life throughout the ages exists a certain relation which is significant for the solution of the problem of nutrition. Plants assimilate the inorganic matter, or, in other words, organize water and the tissue salts, as found in the earth and air, into vegetable substance. Animal life, being of a higher order, must have its original elements in a more refined, or vitalized condition.

All life originated in the water, which in the primordial age almost entirely covered our planet. The lowest animal forms were nourished by the lowest plant forms; the ancient fishes, by the sea plants of that period; the monsters of the carboniferous period, by the coarse and luxuriant vegetation now stored up in the coal beds; while the higher order of plants, especially the fruit trees, belong to the era of man and his immediate progenitors. The fact that the majority of our flower-bearing plants and fruit trees are unknown in a fossil state, clearly demonstrates their recent origin, which must have been simultaneous with that of man.

Thus by reviewing all the sciences bearing upon this subject, we are forced to the conclusion that since man is the most highly developed animal, he can thrive best on such foods as contain the nutritive elements in the purest and most perfect form. Indeed, the original home of man is also the home of the fruit trees, the largest portion of our best known varieties being indigenous to

the south, spreading over the globe simultaneously with the wanderings of the human race.

It would appear that the food of all animals was originally derived from the vegetable kingdom, which is the storehouse of all nutrition, as the animal organism cannot assimilate directly the soil elements. Some naturalists even maintain that no animals were originally carnivorous, but that the evolution of this class of animals was brought about by scarcity of proper plant food in a later geological period, and that still later, probably for the same reason, man was forced by famine to subsist on flesh food.

But as the fact remains that in the process of evolution, this temporary modification in man's diet had hardly any influence on his anatomical structure, this change must have occurred at a comparatively recent date of man's existence on this planet and apparently under the most adverse conditions. The importance of this fact and the conclusions which may be derived from it merit much more consideration than they have been given. Evidence accumulates to support the contention that man with his perfected anatomy has lived on the earth for untold ages, and that natural cataclysms and not evolution developed the change from a frugivorous to an omnivorous diet. It is quite probable that the so-called glacial period, or age of ice, which according to geologists occurred some twenty or thirty thousand years ago and subjected organic life to altogether new conditions, also induced man to deviate from his original and natural diet after he had subsisted on fruits, nuts and succulent plants for many thousands of generations.

Although the exact time of man's prehistoric existence is more or less speculative, his gradual development from his animal predecessors into an intellectual being, unquestionably covered a period of at least a million years. It is also certain that the human race was widely spread over the globe when for the first time enormous ice and snow fields reached far down into the present temperate zones.

Geological research has succeeded in tracing man's ancestry back to the middle and even to the early part of the tertiary period when the climate and configuration of the continents were altogether different from what they are now. All progressive anthro-

pologists agree that man's early evolution took place in the south of Asia where a now sunken continent, called Lemuria, stretched from Madagascar to Sumatra, Java, Borneo, New Guinea and West Australia. Ceylon and the many smaller islands appear to constitute the remains of this once uninterrupted land mass, from which the human race gradually spread over the entire planet.

Man is by no means the direct descendant of the now existing types of apes, but evolved from man-like types long extinct. The oldest human relics yet discovered have been reconstructed by scientists into a primate called *pithecanthropus erectus,* otherwise the erect ape-man; and he belonged to an age so remote that no other trace or record of this creature has been found. The erect ape-man lived, as nearly as science can estimate, one million years ago.

The relics consist of a skull, thigh bone and a few molar teeth which were found in Java by a Dutch surgeon, in 1891, under fifty feet of strata. After a reconstruction of the fragments, the most reasonable conclusions deducible were that they belonged to a being less developed than man, and somewhat higher than an ape. He was apparently between these two types and belonged to a species from which the human race was evolved during a geological period when Java was probably a part of the Asiatic mainland. Before these oldest traces of mankind came to light, other human relics had been discovered in Central Europe, but their age was negligible compared with that of the ape-man of Java.

Antedating the remarkable geological and topographical changes upon the surface of our planet, and during a vast period of time, a uniformly warm climate existed over the entire earth, even within the arctic zones, evidenced by many fossil remains of tropical animals and plants found far in the north. There were probably no alternations of seasons in the primordial world. Day alternated with night, but month succeeded month in almost unbroken sameness. In fact, as late as the carboniferous period, the globe apparently was nowhere colder than the present subtropical zones, or below a mean temperature of 60 degrees F. The bondage of winter did not impede the growth of vegetation, and animals of fabulous size and form developed, indicating wonderful productiveness of nature in that far remote age.

Thus in a climate of eternal spring, when snow and ice were unknown, primeval man lived for thousands of years, and the tropical forests furnished all the necessities of life in abundance. With but little effort, bread-fruit, bananas, dates, nuts, etc., were secured in endless variety throughout the year. It was needless to invent tools and to discover fire, so long as nature provided lavishly all the necessities of life.

These paradisiacal conditions came to an abrupt end with the beginning of the glacial period, and man was compelled to pass through the school of want and deprivation. The antediluvian continent extending to the south of Asia began to sink below the level of the sea. The rising waters of the Indian ocean formed the Persian gulf, the Red and Mediterranean seas, and opened the Straits of Gibraltar in the west. The waters of the Pacific Ocean, in breaking up the old continent, left the numerous East Indian islands, and separated North America from Asia by forming the Behring Straits. With this transfiguration of the continents, also began the differentiation of climatic zones.

Man, hemmed in by an endless sea at the south and the enormous ice fields of the glacial period at the north, was subjected to abject want. Millions of creatures must have perished by terrible earthquakes and inundations, and those who survived were forced into a remorseless struggle for existence. All these changes on the surface of our planet were precipitated within a comparatively short period of time, and naturally created entirely new conditions for animals and plants. While they do not appear to have developed new species, they considerably influenced the character and habits of those already in existence.

Cave deposits and fossil remains indicate that pre-historic man originally migrated along the routes developed by the climatic and topographical changes of the glacial periods to which the Northern and Southern Hemispheres were alternately subjected. The shores of the Mediterranean in the west, and the coasts of the Pacific ocean in the east seem to have attracted our early ancestors, as they were barred from migration to the north by the high mountain ranges of the Himalayas. Further to the west, however, they gained access more easily to the middle and western portions of Europe, where they found an inhospitable region of forests and swamps after the ice had melted. Here they

were forced to contend with the mammoth, the bear, the cave-lion and other species of animals now extinct. These seemingly adverse conditions put man firmly on his feet, taught him the free use of his arms and hands, and developed his ingenuity and cranial capacity in the struggle to defend himself against those monsters of the forest.

Cut off from the prolific tropical soil, a majority of the human race was compelled to resort to the use of many kinds of food hitherto repulsive, and dire want finally forced man to the slaughter of animals in order to provide himself with the necessities for his existence. It is very probable, therefore, that the use of flesh-foods originated during long periods of famine in the glacial era, and that it was during this time that man first became a hunter. The development of the hunter into a warrior followed as a natural consequence, since the different tribes were forced, because of scarcity of food, to contest for the spoils of the chase.

Throughout all ages since the dawn of civilization, the truth has appeared conclusive to all great minds that, in the provision for man's sustenance, it was not natural that he should devour his fellow beings, and thereby place himself on a level of beasts of prey.

The consumption of flesh foods for many thousands of years may indeed have given to man certain carnivorous characteristics, yet his anatomical structure and physiological functions remain unchanged, which conclusively indicate that nature did not design him as a flesh-eating animal, and that sooner or later he must return to his rightful heritage—the products of the soil.

Necessity soon taught man the secrets of agriculture and horticulture, and wherever these industries prevailed, one observes the dawning of real culture and the awakening of man's higher intellectual and moral faculties that lift him so far above the animal world. We find, for example, that in the temperate zones where, by human skill and effort, the cultivation of fruits became most varied and abundant, the life of man is most progressive and prolific, and that his appreciation for the beautiful, the basis of fine arts, is best developed.

The ultimate course of development, as man progresses from a savage to a civilized state, is certainly not in the direction of slaughtering animals for food. The ability to hunt and kill is

naturally of a lower order than the ability to till the soil. The first steps toward civilization were in the displacement of the uncertainties of nomadic life by concentrated efforts in agriculture and tree planting.

In reviewing the long march of evolution of the human race from the earlier part of the tertiary period up to the present, we conclude that for a vast period of time man subsisted on fruits and nuts—his natural diet—which were furnished abundantly by a virgin soil and a congenial climate. During the age of ice, which occurred at a comparatively late period in the history of the organic world, the surface and temperature of the globe were completely changed, and man was forced by necessity and want to take his food, at least in part, from the animal kingdom. However, as his anatomical structure and physiological functions have become firmly established, it is natural that he should return to the diet which nature intended for him.

The biblical allegory of the Garden of Eden would appear to have an historical background, and the more highly developed and thoughtful man of today will perceive that when nature drove our early ancestors from the tropical fields, and condemned them to earn their bread by the sweat of their brow, she enlarged their opportunities for developing latent intellectual powers, and in the struggle for existence opened to their vision, new and grander fields of activity.

In ignorance and want, man was forced to leave his early paradise. Through science, art and industry he will regain it. But, according to the laws of nature, there need be no danger of returning to the misery and savagery of previous ages, for the cultivation of this planet of ours has hardly begun, and vast treasures are still buried beneath its surface, awaiting a higher order of intellectual development and skill to unearth them for the common good of all.

CHAPTER II

Fruits

Fruits, more than other products of the soil, receive the beneficent influences of light, heat and air, through which the electric and magnetic forces of the sun are transmitted. Fruits have, therefore, the highest rate of atomic cell vibrations of all foods, and while we cannot determine by chemical analysis this subtle power, we can feel, when eating fruits, their enlivening effects through our whole system.

In the selection of our foods, fruits must be given the highest place as being most conducive to health and longevity. Fruits keep the alkalinity of the blood in a normal condition, while more concentrated foods, like cereals, pulses, cheese, meat and meat products are more or less acid-forming. The alkaline elements, which are chemically combined with the fruit acids, act as natural laxatives by promoting the action of the secretory glands. They also are indispensable in preserving the normal physical condition of the epithelium cells, upon which the proper functioning of the intestinal walls depends. Fruits supply especially the elements of potassium, calcium, iron and phosphorus in a highly organized form, and in this respect are far superior to cereal products. Figs, grapes, prunes, olives, and many varieties of berries are especially rich in organic iron compounds which we need daily to replenish the red blood corpuscles.

Fruits are also excellent sources of vitamins "B" and "C," the latter being chiefly contained in citrus fruits, a fact that emphasizes the importance of pure, sweet, orange juice, preferably unsweetened, as a valuable article of diet, and one of the best remedies for anemic conditions.

The protein and fat contents of fruits, with a few exceptions, are low, and, while it is possible to live exclusively on a fruit diet, it is best to supplement this with a small amount of nuts or well prepared nut butters. For a week or two a so-called fruit fast is highly beneficial, because it helps to excrete toxins, and to reduce blood pressure.

Fruits are generally divided into three classes, according to the amount of fruit acid they contain, viz., acid, sub-acid, and sweet fruits. The chief fruit acids are malic, tartaric, citric, and oxalic acid. The fruit acids occur usually as acid salts of potassium, sodium or calcium, imparting an agreeable flavor to the juice, and adding a wholesome and stimulating variety to food. Malic acid is chiefly found in apples, pears, currants, berries, pineapples, grapes, and cherries; tartaric acid is characteristic of grapes; citric acid occurs especially in the juice of limes, lemons, grape fruit, oranges, currants, unripe tomatoes and gooseberries; oxalic acid is contained in small amounts in raspberries, tomatoes, grapes and currants, while only a trace is found in oranges, lemons, plums, and apples. During the process of ripening, the fruit acids are reduced as they are slowly transformed into sugar.

Attention should be called to the fact that fruit acids are beneficial only in their organic form as acid salts. Artificially prepared or extracted acids can never produce the wholesome effects of those prepared by nature in the fruits, where they are combined with the alkaline elements. Avoid, therefore, artificially flavored and colored drinks, which are more or less injurious, and cannot replace the acid salts in their organic state.

The principal sweet fruits are dates, figs, muscat grapes, and raisins; sub-acid fruits: apples, apricots, blackberries, blueberries, raspberries, cherries, grapes, peaches, persimmons, plums, and nearly all deciduous fruits. The acid fruits are oranges, lemons, grape-fruit, limes, pineapples, strawberries, loganberries, cranberries, loquats and tamarinds. It is the sugar content of fruits, which is really transformed solar light and electricity, that makes them invaluable as a source of energy. Under the continuous influence of the sun's rays, carbonic acid unites with water and forms various forms of carbohydrates, attaining in the easily soluble organic fruit sugars, their highest form of chemical synthesis. The sugar in fruits, and not animal protein, is nature's great source of potential energy, which manifests itself in the increase of our endurance. Furthermore, in the process of digestion, ripe fruits—provided they are eaten by themselves and not added to a heavy meal—require only a small expenditure of nerve force. They are superior to starch-bearing foods that draw more heavily

on our nerve force, thus overtaxing and gradually weakening the organs of digestion and assimilation.

Scientific experiments have proved that fruit sugar is the most economical source of animal heat and energy, but one must always discriminate between sugar as it exists in fruits or succulent plants, and the refined sugar of commerce, or glucose made from corn starch. Although their chemical composition is similar, fruit sugar is intimately associated with basic elements that are essential in neutralizing the carbonic acid, arising from its oxidation in the system, while refined sugar, though it may act temporarily as a stimulant during exertion, cannot maintain the life processes of the body. When refined sugar is taken, the body cells are rapidly broken down to furnish the blood the necessary alkaline elements for removal of the acids, resulting from its combustion. This explains why the body when fed on proximate food principles, or devitalized foods, will break down sooner than when subjected to an absolute fast.

While fresh fruits do not possess the high nutritive value of the more concentrated cereals, legumes or nuts, they are nevertheless indispensable for maintaining health and vitality; and money spent on fruit is a good investment that will return to us ample dividends by increasing our vitality. If fresh fruits are not available, dried fruits should be used. In nutritive value the dried fruits are similar to cereals. The average amount of carbohydrates, mainly sugar, in dried fruits is about 62 per cent, while the average amount of carbohydrates, mainly starch, in flour is 75 per cent; in bread only 50 per cent. Dried fruits are superior to bread in nutritive value, besides furnishing the necessary alkaline elements, which are lacking in cereals.

Unfortunately the great dietetic and hygienic value of fruits is not yet appreciated by the majority of people. Statistics show that fresh fruits make up only 3.8 per cent of the total amount of food consumed by the American people, and supply only 2.5 per cent of the total carbohydrates. The total amount spent for food in the United States is seven billion dollars. Of this, only 300 million dollars, or less than 5 per cent, are spent for fruit, while nearly 600 million dollars are spent for sugar and candy. Meat. dairy products, and cereals, all acid-forming foods, are consumed to the extent of 4½ billion dollars, with the result that diseases of

the digestive organs are constantly increasing. The production and consumption of fruits can be vastly increased, and, with better systems of distribution, can be made more available as soon as people understand that in fruits they receive food and medicine alike, while drugs and artificial sweets gradually undermine health and vitality.

The daily per capita consumption of fruit in the United States is less than one cent; of refined sugar, candy, preparations artificially sweetened, about four cents; of cereal products, mostly demineralized, the same amount; and for meat about eight cents. As compared with other foods, the amount spent for fruit is ridiculously small. If the per capita consumption would increase only to one pound of fresh fruit daily, or its equivalent of dried fruit, it would mean a yearly consumption of twenty million tons, or more than five times the present rate. But, with the increased use of fruits, the consumption of artificial sweets, cereals and meat would be reduced. This will involve a continuous campaign of education of the public, in which the growers and distributors of fruits should be especially interested, as this is the only way to create an increasing demand for their products.

In temperate zones the season for fresh fruits is comparatively short, but a large portion of each fruit crop is dried, either in the sun, where climatic conditions are favorable, as in certain parts of California, or in dehydraters by means of hot air currents. The process of dehydrating, if performed scientifically, is to be preferred to sun-drying, as it requires a considerably shorter time, and does not expose the fruit to dust and insects. Furthermore, if done economically, it is not more expensive than the sun-drying process.

Attention should be called to the fact that sulphur is used in the drying process of many fruits, such as apples, apricots, peaches, pears, seedless raisins, etc., to obtain a brighter and more uniform appearance, making the article attractive to the eye at the expense of its wholesomeness. If we consider the fact that highly sulphured fruits can be preserved with a water content as high as 30 per cent, while unsulphured, evaporated fruits show on an average a moisture content of no more than 15 or 20 per cent, we must see that the latter are really more economical, besides being free from deleterious substances.

It is often said that a small amount of sulphurous acid in dried fruits is not injurious. To be sure the effects of preservatives are not always immediately noticed, especially in the case of adults with a robust constitution, but finally they will impair the organs of digestion and assimilation. Extensive experiments conducted by Dr. H. W. Wiley, former chief chemist of the United States Department of Agriculture, have shown that the use of sulphurous acid in food is always deleterious; that it never adds anything to the flavor or quality of food, but renders it less palatable and less wholesome. Sulphur, like all other chemical preservatives, such as benzoic acid, salicylic acid, saccharine, etc., acts as a poison to the system. Sulphurous acid seriously interferes with the action of the kidneys, which have to remove all the added sulphur from the body. It also retards the formation of the red blood corpuscles, and destroys the vitamins in the fruit.

Unsulphured, dehydrated fruits are more wholesome and economical than canned fruits. For instance, a can of apricots contains one pound of fresh fruit and twelve ounces of syrup, usually made from refined sugar. One pound of dehydrated apricots represents about six pounds of fresh fruit. In other words, the nutritive value of one pound of dehydrated apricots is equal to that of about six cans of apricots. A carload of 30,000 cans of fruit has a gross weight of about 30 tons, but actually contains only about 15 tons of fresh fruit. A carload of dehydrated fruit of about the same gross weight represents at least 150 tons of fresh fruit. The consumer has to pay for the cost of syrup and canning, also for the increased cost of transportation, at the ratio of about ten to one.

Sun-dried, or dehydrated fruits, should never be cooked. The best way to prepare them for the table is to soak them in water for about twelve hours, or until they are sufficiently softened. In cold weather the fruit may be slightly warmed, but never boiled.

With our constantly increasing and much improved methods of preserving, transporting and distributing food products, many of the tropical fruits and nuts are rapidly coming within the reach of a large proportion of the inhabitants of the temperate zone. In fact, such products as the pineapple, banana, date and cocoanut have become staple foods in many parts of Europe and North America.

Some of the tropical fruits, hitherto unknown or neglected outside their native countries, are now receiving attention not only in the markets of the temperate zone but also among growers in the tropics and in sub-tropical regions, where some of the more hardy of these fruits are being cultivated.

The banana is a striking example of what can be done with most tropical fruits, if methods of harvesting, transportation, and distribution are improved. Eventually other tropical fruits will likewise become staple food products. The avocado, the most conspicuous aspirant for popular favor at the present time, appears in varieties even outside of the tropics, hundreds of acres being planted in Florida and Southern California.

In the not far distant future, such wholesome and nutritious foods as the sapodilla, cherimoya and mangosteen, which are now luxuries on the tables of the rich, will be available in the colder climates, and at prices that will be within the reach of all. The productivity of the tropical soil is marvelously abundant, and there is no reason why we should not amplify our dietary by the addition of nature's most delicious tropical fruits.

As has been shown in the preceding chapter, man is a child of the tropics. For many hundred thousands of years he subsisted on the products of the tropical forests, before climate and configuration of the continents forced him to migrate to the temperate zones, where the struggle for existence was more severe. But even in our less favored climates, where the growth of vegetation is impeded by cold seasons, the soil, if properly cultivated, yields an abundance of nourishment. The fruit trees, especially, show a remarkable fertility which can be always maintained, if the right kind of fertilizer is utilized. The perfection of all hard-wood fruit trees demands plenty of the mineral substances in the soil, which naturally must be replaced.

In the following pages of this chapter, the most common species of fruits, growing in the temperate, sub-tropical and tropical zones, will be briefly described.

Fruits of the Temperate Zones

THE APPLE

The apple *(pyrus malus)* is the most important fruit of the cool temperate zone, over which it is universally cultivated as far north as 60 degrees latitude. All the cultivated varieties have been

derived from the *crab*, a wild apple *(pyrus baccata)*, whose cultivation is pre-historic. The tree is indigenous to most countries of Europe, and, in almost all countries where the oak thrives, it is the longest lived. With the exception of the cherry tree, the apple is the largest of our fruit trees. It is not uncommon to find trees healthy and bearing at the age of one hundred years, often producing from ten to twenty barrels of fruit. The apple tree is hardy and adapted to a wider range of soil and climatic conditions than any other important fruit. It grows well in the North Atlantic states, Ohio, along the eastern shore of Lake Michigan, and in a large part of the Mississippi valley, but the protracted and humid summer of the cotton belt is not favorable to its best development. It does well in the sheltered districts of the Ozark Mountains, while the best and highest priced apples in North America are produced in the Rocky Mountains, Pacific Coast States and southern British Columbia. New York is the leading American state in commercial apple-growing. Four counties on the shore of Lake Ontario in the western part of the state have had for a number of years the most important apple shipping districts.

There are over a thousand varieties of apples in the United States, but most of them are only of local value. The most common varieties in America are Baldwin, Bellflower, Ben Davis, Delicious, Gravenstein, Greening, Northern Spy, Pearmain, Newtown Pippin, Oldenburg, Astrachan, Roxbury Russet, Smith Cider, Spitzenbergen and Winesap. The U. S. census of 1900 showed a total of 210 million trees in what are known as commercial orchards, covering an area of about four million acres that yield over 210 million bushels annually.

An apple tree will rarely bear two heavy crops in succession. This fact, in addition to occasional injuries by frosts, makes it exceedingly rare for all the different apple districts to have a full crop at the same time.

The yield of the apple is often as high as ten tons per acre, especially if properly cultivated and fertilized. It is capable of being produced on rough, unarable land, of which there is a large amount, especially east of the Mississippi River. A large part of the annual apple crop of the United States is used in the form of dried apples, apple butter, apple jelly, apple juice, boiled cider and vinegar. France is the leading cider-producing

country in the world. In northern France and southern Germany, millions of dollars are invested in growing cider apples, and the annual production of France is from 300 to 600 million gallons. This is, naturally, a waste of good food material, as the valuable fruit sugar is converted into alcohol during the process of fermentation. Unfermented apple juice, or sweet cider, can be easily kept in good condition by pasteurization at 160 degrees, or by putting it in cold storage, at 35 to 40 degrees F.

Millions of barrels of apples are now placed in cold storage plants where a temperature within a few degrees of freezing point will keep them for a full year, thus rendering this wholesome fruit available at all seasons.

While the protein content of the apple is low, not averaging more than 0.5 per cent, the sugar content varies from 10 to 15 per cent, as in Baldwins and Spitzenbergens, if fully ripe. Malic acid is found in quantities from 0.3 to 0.6 per cent. Apples contain often as much as 4 to 5 per cent of pectin, or vegetable jelly, upon which the successful making of apple jelly depends. The mineral matter of apples is especially rich in potassium, sodium, magnesium and iron salts, which contribute to the building of blood and bone. A more or less exclusive diet of apples is highly beneficial in cases of hyper-acidity of the blood, as also in diseases of the liver and kidneys, especially diabetes.

THE MEDLAR

The Medlar *(pyrus germanicus)* is common throughout Europe and the British Isles, but not in the United States. In appearance medlars are somewhat like small apples and are not edible until they have undergone a peculiar ripening process, induced by the enzymes of the fruit. Ripe medlars are very rich in sugar, containing as much as 16 per cent, and have a pleasant flavor.

THE PEAR

The pear *(pyrus communis)* is botanically related to the apple, and also has a similar chemical composition, but it contains more sugar and less malic acid. The tree is a native of temperate Europe and Asia. It is now largely grown in California, Oregon and Washington, where it was among the first fruit trees planted.

The best known varieties are the Bartlett, Sugar Pear, Winter

Nellis, Kieffer and Seckel. The Bartlett is the most popular California pear on account of its size, delicate flavor and aroma. The pear tree is hardier than the apple tree and also has a wider range in local adaptation. The larger portion of the California pear crop is shipped fresh to the large Eastern cities, while the remainder is canned and dried.

Most of the dried California pears are quite heavily sulphured, which destroys their hygienic value. Unsulphured, dehydrated pears should be demanded by consumers, who for the most part are unfortunately guided in their selection by the brighter appearance of the sulphured article.

THE QUINCE

The quince *(cydonia oblonga)* was known to the ancient Greeks and Romans, and is now cultivated throughout southern Europe, western Asia and America. It was naturalized at an early period in Persia and in all the countries surrounding the Mediterranean. The quince does well in California and rewards the grower with large crops, but it is not a very popular fruit. It is hard and astringent, and has been improved but little since the time of the ancient Greeks. The flavor of the quince is very much improved by cooking. It is rather extensively used for making marmalade and jellies. The quince contains on an average about 9 per cent of sugar, 1 per cent of protein, 0.47 per cent mineral matter, 0.60 malic acid, and shows a large amount of cellulose, about 18 per cent.

THE APRICOT

The apricot *(prunus armeniaca)* came originally from Armenia, and it is said to be found wild on the southern slopes of the Caucasus mountains. It grows readily in warm and temperate climates, and is one of the early ripening fruits. The apricot is now extensively grown in China and Japan, in some of the protected places of Central Europe, and more recently in different parts of California. The leading apricot growing counties in California, are Riverside, Ventura, Kings, Santa Clara, Alameda and Solano. At present there are about 60,000 acres in the state planted to apricots. From 300 to 400 cars are shipped fresh to the Eastern markets, while a considerable quantity is canned and dried. The principal varieties are the Blenheim, Royal, Tilton and Moorpark.

A well cared for orchard often will produce in the fifth year five tons or more to the acre.

The apricot contains only a moderate amount of sugar, from 10 to 13 per cent, but has about one per cent of fruit acid, a larger amount than either the apple or pear.

The mineral matter of the apricot is distributed as follows:

Potash	59.36 per cent	Manganese	9.37 per cent
Soda	10.26 " "	Phosphoric Acid	13.09 " "
Lime	3.17 " "	Sulphur	2.63 " "
Magnesia	3.68 " "	Silica	5.23 " "
Iron	1.68 " "	Chlorine	9.45 " "

These figures represent the average of over fifty analyses of the whole fruit.

THE PEACH

The cultivation of the peach *(prunus persica)* dates from the remotest antiquity, at least two thousand years before its introduction to the ancient Greeks and Romans. The botanical name seems to indicate Persian origin.

Peaches are now largely grown in south-western Europe, especially in France. They are also grown in southern Canada, in many districts of the United States, as Georgia, Maryland, New Jersey, southwestern Michigan and most extensively in California, which now has the leadership in their production, growing more than all other states of the Union combined. The average production in California is about 300,000 tons, of which about one-half is shipped fresh, the remainder canned or dried. As with apricots and pears, peaches as a rule are heavily sulphured, and, therefore, preference should be given to the unsulphured, dehydrated product, which is sweeter and more palatable.

The average composition of the peach is 80 per cent water, 0.7 per cent protein, 0.1 per cent fat, about 10 per cent sugar, 0.9 per cent acid, 0.7 per cent mineral matter; potash, lime and soda make up the larger portion of the organic salts.

The flesh of the peach is flavored by the presence of a very small quantity of hydro-cyanic acid and fruit ethers. In general, there are two kinds of peaches: free stone, in which the pulp readily separates from the stone; and clings, in which the pulp adheres to the stone. Peaches picked before they are fully ripe and taken

to the market in refrigerator cars do not develop as fine a flavor as those practically ripe when picked. Peaches are made available to the consumer by planting early and late varieties, and by rapid methods of transportation from one region to another.

The principal varieties grown in California are Briggs, Red May, Foster, Crawford, Tuskena, Muir, Elberta, Lovell, Philipps Cling, and the delicious so-called "Saucerpeach" which is not extensively cultivated because it is too tender-skinned for transportation.

THE NECTARINE

The nectarine *(prunus persica)* is closely related to the peach. In fact, it is a variety of peach in a smooth skin. The chemical analysis of the nectarine shows a similar content to that of the peach, and the fruits are the same in natural adaptation. Notwithstanding the many attractive features of the nectarine, it has never become as popular as the peach, owing probably to the fact that it is not so well known. Its smooth skin makes it as easy to handle as the apricot, while the beauty of the product, exceeds that of the peach.

PLUMS AND PRUNES

The word prunes *(prunus)* applies to those varieties of plums that can be dried successfully without the removal of the pit. The fruit has been dried for centuries in some of the European countries, notably France, Bosnia, Servia, Dalmatia, and lately in California, Oregon, Washington and Idaho. Although the sun drying process has for the most part been employed in the treatment of prunes, modern methods of artificial evaporation will be more or less exclusively used by progressive fruit growers, because the process is cheaper in the end, and cleaner, as the fruit is not contaminated by dust, dirt and insects. The production of sun dried prunes increased in California from 10,000 tons in 1890 to 112,000 tons in 1917. The prevailing dried varieties are the French and Imperial prune, the latter being the largest of its kind.

The following varieties of plums are generally shipped fresh: Tragedy, Burbank, Sugar, Silver Prune, Yellow Egg, Satsuma, or Blood Plum, the last being introduced and fruited in this country by Luther Burbank of Santa Rosa. Analyses show that they generally contain from 10 to 20 per cent sugar, one per cent

protein, from 0.3 to one per cent acid, and 0.6 per cent mineral matter. Dried prunes contain as much as 70 per cent sugar and more than 2 per cent mineral matter. The latter is distributed as follows:

Potash	63.83 per cent	Phosphoric Acid	14.08 per cent
Soda	2.65 " "	Sulphur	2.68 " "
Lime	4.66 " "	Silica	3.07 " "
Magnesia	5.47 " "	Chlorine	0.34 " "
Iron	2.72 " "		

Prunes are exceptionally rich in magnesia and iron, and are therefore, excellent blood builders. The above figures represent the average of a number of analyses.

THE PLUMCOT

The plumcot is one of the most striking achievements of Mr. Burbank. It is the cross of the plum and apricot, which he has very fitly named the plumcot.

This fruit is about the size of an ordinary apricot, and has a deep purple, velvety skin. One of its striking features is the brilliant red flesh which possesses a strong sub-acid flavor, rendering it suitable for cooking, jellies and jams. The fruit is in great demand for such uses, but is not yet cultivated to any large extent.

THE CHERRY

Like the apricot, the cherry *(prunus cerasus)* comes to us from the Caucasus and the southern shores of the Caspian Sea, and is now cultivated in most countries of the temperate zone. Over two hundred varieties are grown, some sweet and some sour. In New England, New York, Michigan, Iowa, and more recently in California and Oregon, cherries are now extensively grown, ripening through May, June and July. Although the amount of cherries grown in California is small, as compared with the aggregate weights of some other fruits, the cherry, considering the growth of the tree and the size and quality of the product, is entitled to rank as one of the grand fruits of the Golden State. It is more adaptable to the northern parts of California, Oregon and Washington.

Cherry trees begin to bear when four or five years old, and continue bearing to a great age, sometimes one hundred years or

more. The composition of the fruit varies with the variety, and the flavor is influenced by the soil and climatic conditions. Cherries on the average contain 80 per cent water, 1 per cent protein, 0.8 per cent fat, from 10 to 16 per cent sugar, 0.9 per cent acid, mostly malic, and 0.6 per cent mineral matter.

THE GRAPE

The grape *(vitis vinifera)* is one of the most popular fruits of the temperate zones and is grown as far north as 55 degrees latitude. It is a native of Central Asia and is still found growing wild south of the Caspian sea, the Caucasus and Armenia. The records of the cultivation of the grape and the making of wine go back five or six thousand years. The grape was introduced into Europe by the Phoenicians. Its culture by the ancient Greeks and Romans is well known, and indeed its greater antiquity in some parts of Europe seems to point to pre-historic times, as seeds of the grape have been found in the lake dwellings of Switzerland and southern France.

The leading grape growing countries of the world are those bordering on the Mediterranean sea, especially Greece, Italy, France, Algeria and Morocco. In North America, as compared with that of the old world, the area devoted to grape culture is small. The principal grape growing districts are Virginia, northern New York, the shores of Lake Erie, southern Michigan, Missouri and the Pacific Coast States, of which California takes the leading part. In the Southern Hemisphere, Chili, western Argentina, Cape Colony and Southern Australia grow a considerable amount of grapes, mostly for home consumption.

The larger portion of the European grape crop is annually converted into wine, champagne and brandy, which is really a great economic waste, as the valuable grape sugar is converted into alcohol during the process of fermentation, involving a most unnecessary loss. The virtues of wine, to be sure, have been sung by poets since time immemorial, and millions of people still sacrifice to Bacchus, the god of wine of the ancient Greeks. But, notwithstanding the fact that since the dawn of history many nations have been accustomed to the daily use of wine, the truth is not less potent that the real nutritive and hygienic value of the fruit of the vine can be enjoyed only when fresh or dried,

or in the form of unfermented grape juice, containing the natural grape sugar and the valuable organic salts, which are almost entirely lost in the process of fermentation and distillation.

It is gratifying to note, on the other hand, that in many parts of Europe the so-called "grape cure" during the harvest has become very popular. It is used in many health resorts in southern Germany, Austria and northern Italy, where people live on grapes exclusively from four to six weeks, increasing the quantity from three to eight pounds daily, according to age and constitution. The cure is especially helpful in diseases of the respiratory organs and kidneys, also in anemic conditions. The beneficial action of the grape cure is due chiefly to the simplicity of the diet, which furnishes the protein and carbohydrates in most assimilable form, while the large proportion of alkaline salts, such as potash, lime, magnesia and iron, reduce the acidity of the blood. Fresh grape juice also contains vitamins "B" and "C" which are partly lost in the pasteurized or preserved juice.

The chemical analysis of the grape shows a great many variations, according to climate, soil, topography of the country, etc. The sugar content may be from 15 to 30 per cent, protein from 0.6 to 1.5 per cent, pectin about 1 per cent, tartaric acid from 0.5 to 1.2 per cent, while mineral matter averages about 0.5 per cent.

In the central and northeastern portions of the United States, the Concord grape predominates. It is used mostly fresh and in the production of unfermented grape juice. Other popular eastern varieties are the Catawba, Delaware and Niagara grapes. Among the Pacific Coast States, California now leads in grape growing, producing over one million tons annually. The principal varieties are the Mission (the first variety grown in California), Almeria, Black Hamburg, Black Malvoise, Chasselas, Cornichon, Emperor, Feherzago, Malaga, Muscatel, Muscat of Alexandria, Tokay, Zinfandel. The California Concord and Isabella do well in the coast districts. The Black Corinth, known as "currants" when dried, is also raised to a certain extent, but most of the currants sold in the United States are imported from Greece. Sultanas and Thompsons are the best known seedless varieties of grapes.

Prior to the enactment of the prohibition laws, about 250,000 tons of California grapes were annually converted into wine, sweet wine and brandy every year. As the home manufacture of wine

has become a national industry, the demand for wine grapes is increasing rather than diminishing, and prices for these grapes are now higher than ever before in the United States. Growers of wine grapes, who expected to become bankrupt, found themselves suddenly in an enviable position, while their land doubled and tripled in value within a few years. This is another illustration of the fact that we cannot change ingrained habits simply by legislating against them. People who immigrated to America from southern Europe have been accustomed to the use of wine for thousands of years, and it will require a good deal of sound education to effect a change in their methods of living.

About 250,000 tons of California grapes are shipped fresh for table use. The best varieties for eastern markets are the Cornichons, Emperors, Malagas, Muscats and Tokays.

The raisin industry, which consumes the balance of the California grape crop—about 600,000 tons—has made wonderful progress since the growers became well organized. The raisin crop in 1912 amounted to 170 million pounds, and increased to 264 million pounds in 1920, while the present production is over 400 million pounds, (200,000 tons). Muscat grapes make the best raisins for table use, while the seedless grapes, Sultanas and Thompsons, are excellent for many culinary and manufacturing purposes. California raisins are among the most wholesome and nutritious dried fruits produced in the world. They are generally dried in the sun, without sulphur, as the dry heat of the interior valleys rapidly takes up the moisture of the fruit.

The average of seven analyses gives the following composition of raisins:

Water	14.60	per cent
Protein	2.60	" "
Fat	3.30	" "
Sugar	76.10	" "
Mineral Matter	3.00	" "

Raisins are rich in potash, magnesia and iron, and should be used in place of artificial sweets.

THE AMERICAN PAWPAW

The American pawpaw *(asimina triloba)* must be distinguished from the tropical papaya tree *(carica papaya)* whose fruit is often called "papaw" or "pawpaw." The papaw tree is a native of the

United States, and seems to grow best in the lowlands of the Mississippi valley. The fruit was much valued by the Indians, from whom the early European settlers learned its use. As the flesh of the fully ripe fruit is very soft and easily bruised, it cannot be shipped conveniently to any great distance, and is, therefore, little known outside of the regions where, for the most part, it grows wild.

Professor C. F. Langworthy and A. D. Holmes, of the United States Department of Agriculture, have recently made some very valuable and interesting investigations of this most wholesome and nutritious fruit, which deserves more general cultivation and wider use. There is no doubt that with proper care the papaw can be cultivated throughout the warmer regions of the United States.

The papaw tree varies in size from a bush to a medium-sized tree, and is a prolific bearer. The fruit, which matures about the middle of September, resembles in appearance a small banana more than any other fruit, but it is practically cylindrical and has both ends rounded. It reaches a length of four to six inches, with a diameter of one to two inches. The stem of the papaw is attached a little to one side of the axis of the fruit, so that it hangs almost horizontal, rather than vertical. In favorable localities the fruits often reach a weight of three-quarters of a pound to a pound, although most of them are smaller, particularly when clustered on the branches. On account of the close resemblance of its fruit to the banana, the papaw tree is often called the "little wild banana tree."

The fruit contains a double row of shiny black seeds, arranged at right angles to its axis, constituting nearly one-fifth of the pulp, which is smooth, creamy, and of rather pungent aroma. In this respect the papaw has much in common with the tropical custard apple *(cherimoya)*. The skin of the fruit is very thin and is generally eaten with the pulp.

One of the most striking characteristics of the papaw is its high percentage of protein, in this respect surpassing any other variety of fresh fruit known. The edible portion of the fruit shows the following composition:

Water	76.6 per cent	Carbohydrates	
Protein	5.2 " "	(mostly sugar)	16.8 per cent
Fat	0.9 " "	Mineral Matter	0.5 " "

It is, therefore, fully equal, if not superior in nutritive value to the banana. Like the latter, the papaw, if cut in half, can easily be dried, especially by means of a modern dehydrater, in which temperature and moisture can be well regulated. The papaw, on account of its dietetic and hygienic value, is certainly worthy of consideration and of further study.

SMALL FRUITS

The small fruits, or berries, have the advantage over tree fruits, in that they can be made to yield profits often in a year or two after planting, while in the home gardens they will supply fresh fruit of various kinds for the table throughout a long season. Furthermore, because of the fact that berries provide a source of immediate income and only occupy the soil for a limited length of time, they are used considerably as inter-crops in orchards. If properly managed, no injury to the trees results, and until the trees come into bearing, the grower has a source of revenue.

Berries consist of a more or less watery pulp, containing a mass of seeds. The various kinds of berries contain from 85 to 90 per cent of water; 8 to 12 per cent of fruit sugar; a small amount of protein, fat and pectin; from 0.4 to 0.7 per cent of mineral matter, mostly potash, lime and magnesia; and, in the currant and strawberry, a considerable amount of iron. The fruit acids, mostly in the form of malic acid, amount to from 1 per cent to over 2 per cent.

The principal varieties of berries are the Blackberry, Cranberry, Currant, Dewberry, Elderberry, Gooseberry, Huckleberry, Loganberry, Raspberry and Strawberry. Most of them, with the exception of the strawberry, are grown on low bushes, or small trees. Many of these varieties grow wild over vast areas in the United States. Likewise in the Eastern Hemisphere, many of these varieties have been known in a wild state from earliest times.

THE BLACKBERRY *(rubus nigrobaccus)* has been improved greatly in size and appearance by cultivation. The berries are red before they turn black on becoming fully ripe, and when at their best, contain about 8 per cent sugar and 1 per cent acid.

THE CRANBERRY *(vaccinium macrocarpon)* grows on vines or low bushes in the temperate zone of both Europe and America. It has a rich red color and an abundance of pectin, which makes it

valuable for making sauces and jellies. The cranberry in its ripe state contains about 10 per cent sugar and 2.3 per cent malic acid. It is one of the few fruits that naturally has a small quantity of benzoic acid. Cranberries are highly beneficial in diseases of the liver and kidneys when eaten without refined sugar, because of their large content of organic acids that exist in the form of malates of potash and lime.

Currants *(ribes)* are grown in three varieties, red, black and white, and contain about 7 per cent sugar and 2.25 per cent malic acid, mostly in the form of malate of potash. Black currants are especially appreciated for their general medicinal value.

The Dewberry *(rubus vitifolius)* grows wild abundantly in the United States and has a very delicate flavor. Its chemical composition is similar to that of the blackberry.

The Elderberry *(sambucus canadensis)* grows on shrubs which often attain a considerable size. It is found wild throughout the temperate zone. The ripe berries make a dark-colored juice, which may be preserved with the addition of a little honey.

The Gooseberry *(ribes grossularia)*, which is also found wild throughout Europe and North America, has been very much improved by cultivation. While some of the small wild berries are thickly covered with spines, some of the improved large varieties have an almost smooth skin. Under favorable conditions they contain as much as 13 per cent sugar, while the acid is not higher than 1 or 1.5 per cent. They also have a considerable amount of pectose, while among the organic salts, potash, lime and magnesia predominate.

The Mulberry *(morus alba)* also grows wild on medium-sized trees over a large area both in the United States and Europe. The berries are very sweet, containing as much as 15 per cent sugar, and little acid. In the Orient the tree is cultivated for the silk industry, as the silk worm feeds on its leaves.

The Raspberry *(rubus strigosus)* is extensively cultivated, but like all berries, grows wild in most parts of the United States. It has a very delicate and distinct flavor for which it is highly esteemed. Fully ripened raspberries make one of the most delicious and refreshing fruit juices. In places where the berries are grown on a commercial scale, they are often dehydrated. Ripe

raspberries contain about 1 per cent protein, 8 per cent sugar and from 1 to 1.5 per cent malic acid.

The Loganberry is a hybrid plant obtained by crossing the red raspberry and the blackberry. The fruit is large, long, dark-red in color, sub-acid in flavor, and good in quality. It makes an excellent unfermented fruit juice. It is grown in nearly all the berry sections of the United States.

The Huckleberry *(gaylussacia resinosa)* grows wild on small bushes throughout the North Temperate zone. It is also found in large quantities on waste lands in the northern United States and southern Canada, where it is gathered by the natives and shipped to distant towns and cities. Huckleberries can be dried easily so that they can be kept during the winter. The ripe berries contain about 80 per cent water, 7 per cent sugar, 1 to 1.6 per cent malic and citric acid. They are rich in potash, lime, and magnesia salts.

The Strawberry *(fragraria chiloensis)* undoubtedly is superior to other berries on account of its excellent flavor and great hygienic value. Although it grows wild in many places, it has been extensively cultivated since the sixteenth century, and by continuous improvement a large variety of luscious berries is now grown throughout the temperate zones. Strawberries contain from 85 to 90 per cent of water; 0.7 to 1 per cent protein; 7 to 8 per cent sugar; 1 to 1.6 per cent malic and citric acid, and 0.6 to 0.8 per cent of mineral matter, which includes a larger amount of iron than contained in any of the other berries.

Tropical and Sub-tropical Fruits

Citrus Fruits

THE LEMON

The lemon *(citrus limonum)* was introduced into Palestine and Egypt by the Arabs in the tenth century, and into Europe at the time of the Crusades.

Although lemons have been grown in California for half a century, it is only during the last 25 years that they have risen to considerable commercial importance. The lemon tree is less hardy than the orange and comprises from 10 to 15 per cent of the citrus crop. The principal varieties of lemons grown in Cali-

fornia are the Eureka; the Genoa, imported from Genoa; the Lisbon, from Portugal; Villa Franca, imported from Europe, and the Bonnie Brae, mostly grown in San Diego County, California. The average annual yield in California, on about 4,500 acres of lemon orchards during a period of five years was about 196 boxes per acre. In the United States there are at present over 30,000 acres of lemons in bearing. Practically all the imported lemons come from Sicily, where the production is very large.

Chemical analysis of lemon juice shows the following constituents:

Water	88.00	per cent
Protein	0.94	" "
Sugar	2.08	" "
Mineral Matter	1.00	" "
Citric Acid	7.66	" "

As in the orange, potash, lime, magnesia, and phosphoric acid predominate in the mineral content of lemons. Lemon juice should always take the place of vinegar in the preparation of vegetables. The medicinal value of the lemon consists of its high percentage of citric acid, combined with potash and lime, and its large amount of vitamins "B" and "C."

THE CITRON

The citron *(citrus medica)* of commerce was grown by the California Missions in the early days, but is now grown only to a small extent in Riverside County, California. It is extensively cultivated in China, Persia and the Mediterranean countries. The tree is similar to the lemon, but the fruit is much larger, being from four to six inches long. The interior consists of a somewhat acid pulp, from which a juice is pressed, which is used like lemon juice. The rind of the citron, which is thick and spongy, is frequently used in candied form.

THE LIME

The lime *(citrus acida)* is grown and cultivated especially in the West Indies, Italy and Florida; also to a small extent in California. The fruit is oval, yellow, about one inch long, and not suitable for eating. It is highly valued for its large content of citric acid (from 7 to 8 per cent), and the essential oil and the lime juice that may be obtained from it. The chemical composition of the lime is about the same as that of the lemon. Lime juice is also very valuable, as it contains the anti-scorbutic vitamin

"C," and is, therefore, indispensable to those who are deprived of fresh vegetables for a long time.

THE POMELO, OR GRAPE FRUIT

The pomelo *(citrus grandis)* was one time almost exclusively grown in Florida, but its cultivation has increased in recent years, and considerable quantities are produced in Riverside, Tulare, San Diego and other citrus counties of California. The pomelo, which originally came from China, is the largest of the citrus fruits. It contains a considerable amount of acid, although not so much as the lemon, and also a peculiar bitter principle. It is best served cut in halves and eaten with a teaspoon, after some honey has been added, to suit the taste.

The juice of the fully ripened fruit contains on an average:

Water	87.00 per cent	Sugar	7.00 per cent
Protein	0.56 " "	Citric Acid	1.00 " "
Mineral Matter	0.56 " "		

The mineral matter is composed as follows:

Potash	43.01 per cent	Phosphoric Acid	11.09 per cent
Magnesia	3.92 " "	Sulphuric Acid	3.39 " "
Lime	7.34 " "	Chlorine	1.38 " "
Iron	1.28 " "		

THE KUMQUAT

The kumquat *(citrus japonica)* is one of the smallest of the citrus fruits. It is a native of China, and has been grown in Florida and California for some time. The fruit is bright golden yellow, growing in clusters, and is only about 1 to 1½ inches long. The thin rind is sweet and aromatic, and the entire fruit, rind and all, is usually eaten. The tree is exceedingly ornamental, especially when covered with its bright yellow fruit. It makes a delicious preserve if sweetened with honey.

THE ORANGE

The orange *(citrus sinensis)* is probably a native of southern China, whence it was introduced into Syria, Arabia, and the western Mediterranean countries. It was brought to America by the Spaniards. In the United States we have three well developed orange regions: Central and southern Florida, the Delta region of the Mississippi, California, and some parts of Arizona. At present the great orange centers in California are in Los Angeles, San

Bernardino, Riverside and San Diego counties. But there are various orange centers in central and northern California where the successful culture of this fruit has been continuous for a number of years.

The standard varieties are the Washington Navel, the Paper Rind, the Saint Michael, the Valencia Late, the Blood orange, Tangerines, and the Mediterranean Sweets. The superior quality of the Navels grown in California commands the winter market, but the St. Michael and the Valencia are good oranges, and can be left on the tree until May or June.

The introduction, by the United States Department of Agriculture, of the Washington Navel orange in 1870 from Bahia, Brazil, under the name of "Bahia" orange, and the sending of two trees propagated from those introduced from Brazil to Mrs. L. C. Tibbets, Riverside, California, in 1873, mark the most important epoch in the history of citrus culture in California. At that time there were many types of oranges grown in Southern California, most of which were descended from trees planted in gardens around the old Missions.

At present the orange industry in California represents an investment of about $150,000,000. During the season of 1916-1917, over 15 million boxes were shipped, representing a value of over $33,000,000. The average annual yield on a twenty acre orange grove from 1906 to 1911 was about 158 boxes, or 8,000 pounds of fruit per acre.

A number of chemical analyses from the juice of ripe oranges show on the average the following constituents:

Water	87.00 per cent	Fruit Sugar	10.00 per cent
Protein	0.80 " "	Citric Acid	1.25 " "
Fat	0.20 " "	Mineral matter	1.25 " "

The last is composed as follows, giving the average of nine analyses in per cent of the total amount:

Potash	48.94 per cent	Soda	2.50 per cent
Lime	22.71 " "	Magnesia	5.34 " "
Iron	0.97 " "	Manganese	0.37 " "
Phosphoric acid	12.37 " "	Sulphuric acid	5.25 " "
Silica	0.65 " "	Chlorine	0.92 " "

Pure orange juice is especially valuable for growing children on account of the high content of lime and magnesia, both bone

building elements. Although the orange contains a large amount of citric acid, the juice, on account of its large amount of potash, is decidedly alkaline in its reaction. Special attention should be called to the fact that nine analyses show the following variation in the percentage of composition:

Lime	16.37	per	cent	to	27.70	per	cent
Soda	1.67	"	"	"	4.09	"	"
Iron	0.41	"	"	"	2.00	"	"
Phosphoric acid	9.75	"	"	"	14.46	"	"
Silica	0.31	"	"	"	0.94	"	"

Proper fertilization of the soil will undoubtedly increase the contents of soda, lime, and iron in the fruit, and make it still more valuable from a hygienic point of view.

The evergreen nature of the orange tree and its heavy bearing properties are a severe drain on the soil, and annual fertilization with cover crops is necessary when trees are several years old—cover crops being in all cases much superior in their yield of essential soil requirements, as well as being more wholesome and hygienic than animal or stockyard fertilizers.

THE TANGERINE

The tangerine *(citrus nobilis)* appears to be a race distinct from the orange and indigenous in northeastern India and southern China. The leaves and blossoms are smaller than those of the orange, and exhale a peculiar aromatic odor. The branches are slender and the fruit is flattened, with segments loosely adhering, forming a hole in the center. The rind is saffron yellow, smooth, and glossy. When fully ripe the fruit is exceedingly juicy and of a delicious flavor.

THE AVOCADO

The avocado *(persea gratissima)* is one of the most ideal of all fruits. It is indigenous to the mainland of tropical America. Its chemical composition shows a high food value. The average of ten varieties analyzed shows:

Water	68.85	per	cent
Protein	2.00	"	"
Fat	21.60	"	"
Carbohydrates	6.00	"	"
Mineral matter	1.55	"	"

Some varieties show a fat content as high as 29 per cent, protein 2.43 per cent, while the total amount of organic salts is much

greater than that contained in many other fresh fruits. Potassium, sodium, calcium, and magnesium compose more than one-half of the total mineral matter, giving a preponderance of the alkaline elements, while nuts show an excess of the acid-forming elements.

Avocados grow on beautiful evergreen trees which are larger in some instances, than large apple trees. The hardier varieties will stand about as much frost as the orange tree. The size of the fruit varies from a few ounces to several pounds. The shape varies from round to oval or pear shaped. This is perhaps the reason why the avocado is sometimes called "alligator pear," although generally it bears no relation to the ordinary pear. The color varies from light green to dark purple, sometimes black. The fruit, which has one large seed, should not be removed from the tree until it is mature. Avocados become soft when off the trees within one or two weeks after picking. When ready to eat they should be soft enough to spread on bread like butter.

The avocado differs from most fruits in that it is not juicy, being neither acid nor sweet. Its smooth and buttery consistency and rich nutty flavor distinguishes it from all other fruits. It is richer in protein than most fruits, while the best varieties have more than twenty per cent fat in a very palatable and digestible form, superior to butter fat. In fact, this fruit replaces meat to a very large extent in all countries where it can be grown successfully. It is an excellent addition to combination salads, as it supplies both protein and fat, which are deficient in vegetables.

The high prices, which have made the avocado so far prohibitive to many people with moderate means, have been due to the fact that the demand has been much greater than the supply. As the supply increases, the price will, of course, go down, but one should not expect the price to decrease to that of apples or peaches. New methods of dehydration or preservation, may bring the fruits of Mexico, Central America and the West Indies in large quantities to the United States, and may make the fruit almost as popular as the cocoanut.

Although the avocado attains its greatest production in the tropics, it does well in many favored places of sub-tropical countries. The rapid growth of the avocado industry in Southern California and Florida forms a new and important chapter in the horticultural industries of the United States. From a few scattered trees in 1915,

the number has increased to many thousands of trees in orchard form, and thousands of trees are being planted each year. The United States Government sent Mr. Wilson Popenoe, an expert horticultural explorer, to the parts of the world where the avocado grows to perfection to secure budwood of the choicest varieties for use in this country, and is offering every possible assistance to encourage the growing of avocados where climatic conditions will permit. In an interesting article, "Avocados as Food in Guatemala," Mr. Popenoe says:

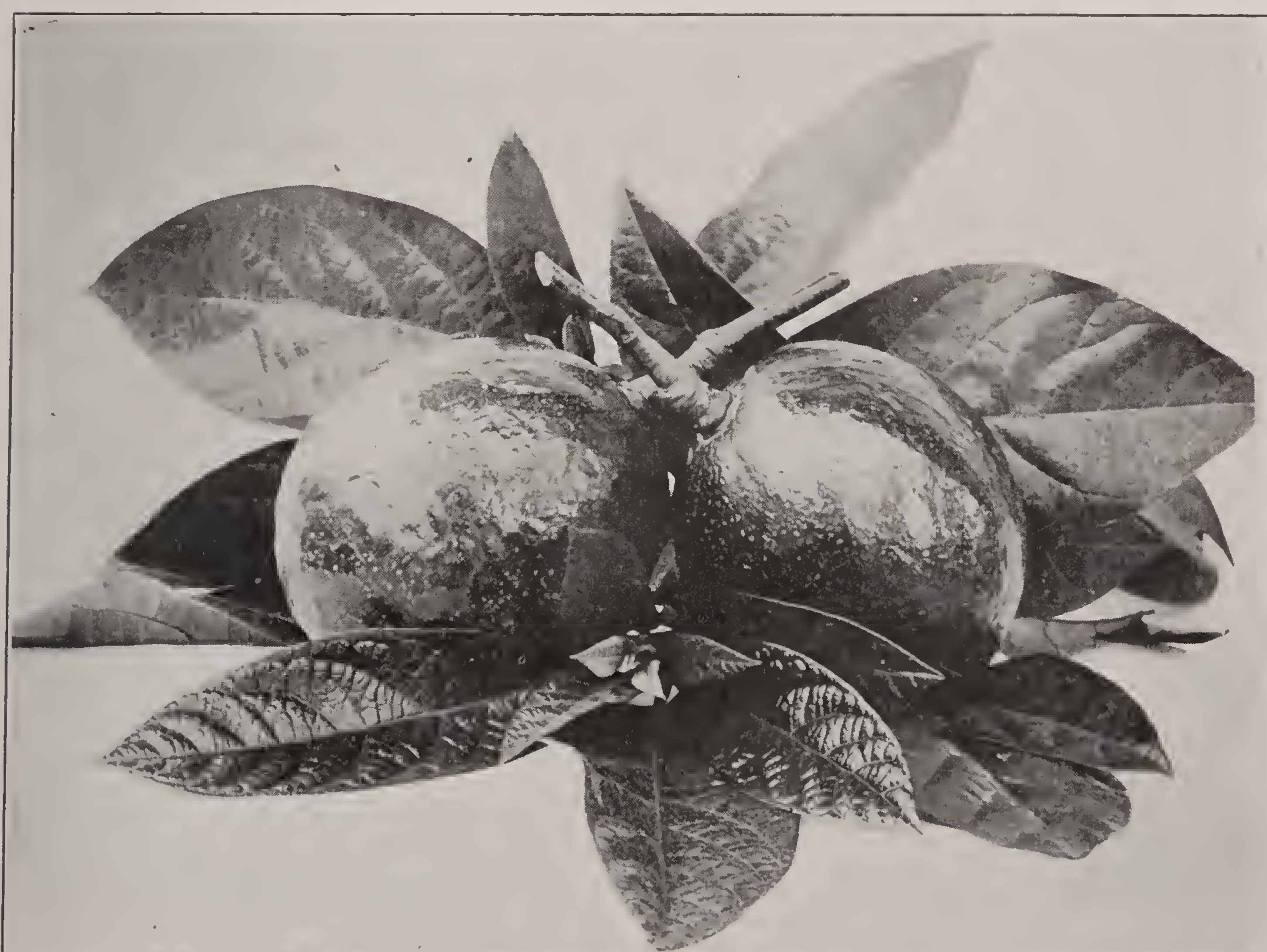
"As far as can be judged from the experience of the past ten years, Americans in general are going to like the avocado immensely. Probably not one per cent have tasted it as yet, but among those who have been fortunate enough to do so, there is no question regarding the popularity of this fruit. It must be admitted that the avocado is delicious. It is a taste which grows upon one, The delicately rich flavor of its soft creamy flesh is pleasant and satisfying to a degree rarely experienced. While it is most commonly eaten with the addition of nothing more than a little salt and a dash of lemon juice, it blends admirably with certain other foods.

"In certain portions of the Guatemalan highlands the avocado is eminently at home. It not only grows in almost every door yard, but also in the edges of cultivated fields and along the road sides, yielding generously of its handsome fruit, although it receives no care from man. It is difficult for one who has not actually visited these regions to appreciate the extent to which the avocado replaces meat in the dietary of these industrious folk. It must be understood that meat, in Guatemala, is a luxury to be indulged in mainly by the well-to-do, its use among the poorer classes being very limited.

"The abundance of avocados, their cheapness, and the long season during which they are available make it possible for even the poorest natives in all principal avocado regions to use them as a daily article of food throughout more than half of the year. An avocado, four or five tortillas (small round cakes of coarsely ground maize) and a cup of coffee are considered by many Indians the constituents of a good meal. The cost of such a meal is seldom over two cents, for outside the larger cities avocados are rarely sold for more than half a cent each.

"No data regarding the annual production of avocados in Guatemala are available. While avocados are grown in practically all parts of Guatemala, certain regions are especially renowned for their production and supply most of the fruits sold in larger cities and towns. These regions all lie at elevations above 2,500 feet and are not only the greatest producers of avocados but the great horticultural centers of the republic. Favored by climatic condi-

TAFT AVOCADO TREES IN FULL BEARING, SOUTHERN CALIFORNIA



THE MESERVE AVOCADO ORIGINATED NEAR LONG BEACH, CALIFORNIA

tions and possessing an exceedingly fertile soil, they have long been cultivated intensively by the Indians.

"In Florida, an orchard of Trapp avocados at five years of age has produced an average of four crates of fruit per tree. Since there are 80 trees planted to the acre, this gives 320 crates of fruit per acre. Each crate contains an average of 40 avocados, which weigh about 12 ounces each. In other words, a crate contains 30 pounds of fruit. This acre therefore produced 320 times 30 or 9,600 pounds of fruit."

An article entitled "The Avocado in Florida" appeared in *The Country Gentleman* under the date of April 29th, 1922, from which the following paragraphs are quoted:

"As a result of his observations Mr. Krome has been convinced that future cultural practices with the avocado must include careful thinning of the fruit, whenever this tendency to overbear manifests itself. This grower has taken as many as thirty-two crates of avocados from a single tree.

"From between January 15th and March he didn't have a sale of avocados in New York under $32.50 a crate. He frequently had them bring $40.00 a crate up to the time when Central American avocados began to come in and break the market down to $15.00 a crate."

According to these figures thirty-two crates at prices received brought a return of about $1,000 per tree. Basing these estimates on individual trees, an acre of the best budded varieties will produce at least 30,000 pounds of fruit in a year. At a price of even twenty cents a pound, this would mean a gross income of $6,000 per acre.

A number of full-grown avocado trees are scattered over Southern California and bring very remarkable returns. There is growing on the property of Joseph H. Walker, 1547 Los Palmas Avenue, Hollywood, a tree that in one year has produced over $1,800 worth of fruit. Mr. Walker has had crops from this tree worth $1,500 and $1,200. The tree is very large now. By assuming that there were only twenty such trees per acre, they would bring a royal income.

The old Taft tree at Orange, California, has produced as high as $800 worth of fruit in one year. A few years ago there was a tree in the Whittier District that produced $2,100 worth of fruit and $1,800 worth of budwood in one year. Allowing one hundred trees to the acre with an average crop of only $50 per tree, the income would be $5,000 per acre.

There may be found throughout Southern California along the frostless foothills of the Sierra Madre Mountains, locations which are ideal for the growing of the avocado, as far as climatic conditions are concerned. Such lands for the growing of this veritable "tree of gold" are very valuable.

Miami, Florida, is now one of the largest producing sections of the South; the fruit there usually ripens late in summer. The average price, when the fruit is plentiful, is twelve cents a pound and at that figure the daily consumption is equal to one-fourth pound per capita of this district, the fruit being greatly in demand by all classes.

In the city of Havana, the average per capita consumption is even more during the season when the fruit is cheap. Should the average daily per capita consumption in the United States reach only one-twentieth of a pound a day, it would require 500,000 pounds a day or 1,500,000,000 pounds for 300 days of the year. This would be the product of 50,000 acres at the rate of 30,000 pounds per acre, if the trees were in full bearing.

There are about 180 varieties of avocados classified in California. Seedling trees have grown sixty feet high with fifty feet spread. Budded trees bear in from two to four years, according to variety. Seedling trees bear in from five to seven years. Orchards may be so arranged that fruit may be had all the year around. The time will come when people in Southern California, instead of planting the pepper, acacia and other trees for shade, will be planting the avocado, wherever there is no danger from severe frost.

THE BANANA

The banana *(musa sapientum)* is to the inhabitants of the tropics what the potato, sweet potato and other starchy roots are to the people of the temperate zones. It thrives best where the climate is moist and warm and the rainfall sufficient. As a producer of food, the banana tree is almost without a rival, and while cereals and potatoes require much labor and constant tillage of the soil, this tree, if kept free from rival plants, will grow rapidly and produce fruit after a few months. No yearly replanting is necessary, and the tree will produce continuously for many years. It is reported that in southern Brazil, banana plants, with slight care, have stood for thirty years, and still produce bunches of seventy bananas

THE GUAVA (see page 220)

MEXICAN AVOCADOS
Average Weight Over One Pound

each. The average yield per acre is from ten to fifteen times more than that of any of the cereals grown in northern countries, and even excels the prolific potato. An average annual yield of 400 bunches per acre, weighing from 50 to 75 pounds, is considered a good crop. In 1913, the banana acreage in the West Indies and Central America amounted to 520,000, and this large expanse has since been greatly increased.

The banana is shipped in a green state, when most of the carbohydrates are still in the form of starch, which is converted into sugar during the ripening process. When the skin becomes yellow and shows dark spots, the edible part of the fruit is in best condition to be eaten without further preparation. In some localities of the West Indies and Central America, bananas are now dehydrated, which permits the ripening of the fruit on the tree. With the improved processes of dehydration, bananas can be shipped to greater distances and will have a larger field of distribution.

During the ripening the starch of the banana is changed into soluble carbohydrates, chiefly cane and invert sugars and dextrin. The total amount of carbohydrates is about 20 per cent, of protein 1.3 per cent and mineral matter 0.8 per cent, consisting largely of potash, sodium, and chlorine, while it is deficient in lime and iron. In the growth of the banana plant, the elements of lime and iron pass into the heavy stem and big leaves and are therefore lost for human nutrition. Ripe bananas should therefore be supplemented with green leaf vegetables. The unripe banana is often dried and ground into flour which is equal in nutritive value to wheat flour.

A close relative to the banana is the *plantain* which often reaches a length of twelve inches and a diameter of two and a half inches. It is generally eaten cooked or baked, in which form it is more palatable than when raw. Its constituents are about the same as those of the banana.

The banana very closely resembles the potato in chemical composition, as is shown by the following table:

	Potato (Average)	Banana (Average)
Water	78.3 per cent	75.3 per cent
Protein	2.2 " "	1.3 " "
Fat	0.1 " "	0.6 " "
Total carbohydrates	18.0 " "	22.0 " "
Mineral matter	1.0 " "	0.8 " "

An analysis of the mineral matter made by Professor Samuel G. Prescott, Massachusetts Institute of Technology, gives the following figures in per cent of the total amount of organic salts:

Potash	43.55 per cent	Iron oxide	0.18 per cent
Soda	15.11 " "	Phosphoric acid	7.68 " "
Lime	1.82 " "	Sulphur Trioxide	3.26 " "
Magnesia	6.45 " "	Chlorine	7.23 " "

The banana has the advantage over cereals in that its mineral matter is largely made up of base-forming salts, while that of the cereals has an excess of acid-forming elements.

Most of the bananas imported into the United States come from the coasts of Guatemala, Honduras, Costa Rica, Panama, northern Columbia, while a large percentage is also supplied by the West Indies. Southern Brazil sends its bananas to Uruguay and Argentina, while southern Australia and New Zealand are supplied by Queensland and the South Sea Islands.

The banana has been successfully grown in a few sheltered and frost-free spots of Southern California and Florida, where the fruit has matured to fair size, having a delicious and mellow flavor.

THE BREAD FRUIT

With the cocoanut and the banana, the bread fruit *(artocarpus communis)* forms one of the three leading staple foods of the tropics, especially in the South Sea Islands, Ceylon, and in some parts of southern India. The fruit is also cultivated on a small scale in the West Indies, the coast regions of Mexico, Central America, and tropical South America. The tree, which reaches a height of from 40 to 60 feet, is one of the handsomest of the tropics. It has large ovate, leathery leaves which are entire at the base, and have from three to nine lobes toward the upper end. Male and female flowers are produced on the same tree. The ripe fruit, which is composed of the matured ovaries of the female flowers, is round or oval in form, generally from four to eight inches in diameter. It is green when immature, but turns brownish and yellow while ripening. The pulp is fibrous, pure white in the immature fruit and yellowish in the fully ripe state. The fruit grows on small short branches, commonly in clusters of two or three. It is often eaten before it becomes ripe, while the pulp is still white and mealy and of a consistency between that of bread and sweet potatoes.

Some of the South Sea islanders bake it by means of heated stones in a hole, with layers of stones, bread fruit, and green leaves alternating.

It is similar to the banana in food value, and takes the place of bread in the Pacific Islands.

Ripe bread fruit from Samoa, of the seedless variety, shows the following analysis:

Total solids	26.90 per cent	Protein	1.57 per cent
Fat	0.50 " "	Mineral Matter	1.15 " "
Sugar	14.60 " "	Crude fiber	1.00 " "
Starch	9.20 " "		

THE CAROB

The carob tree *(ceratonia siliqua)* whose fruit is commonly known as St. John's bread, is a native of the shores of the Mediterranean Sea. It is found chiefly in the islands of Sicily, Cyprus, Malta, the southern part of Sardinia, and the Adriatic coast of southern Italy. The Spaniards brought it to Mexico and South America, and the English to South Africa, Australia and India.

The carob was introduced into the United States in 1860. About 8,000 plants were distributed, which were sent mostly to the Middle and Southern States, and a few reached California. In Southern California bearing carob trees are frequent. Experience has shown that the trees, when young, are no hardier than orange trees. When once established, however, the carob is more resistant to frost than the orange.

The carob belongs to the legume family, and is the only species of the genus Ceratonia, derived from the Greek, *keronia,* meaning horn, referring to the form of the pod. The tree is a handsome evergreen, 40 to 50 feet high, with large compound leaves. The reddish or yellowish flowers appear from October to December, although the blooming season may extend much later. As a rule, male flowers are on one tree and female flowers on another, although occasionally trees are found that produce male and female flowers in one cluster.

In Europe the wild-growing carob pods have been used extensively as a food for cattle, but on account of the large amount of fiber, only to a small extent as a food for man. There is no reason, however, why the carob, by cultivating varieties that show

a minimum amount of crude fiber, should not be utilized more commonly as a human food.

It is one of the most prolific bearing trees, and according to chemical analysis, one of the most nutritious foods. The average of sixteen analyses of the dried pods shows the following contents:

Water	11.50	per	cent	Nitrogen free extract			
Protein	4.50	"	"	other than sugar	36.30	per	cent
Fat	2.37	"	"	Crude fiber	8.78	"	"
Sugar	34.31	"	"	Mineral matter	2.72	"	"

Some of the varieties examined had a sugar content of 45 and 50 per cent, while the crude fiber was as low as 3.14. Small quantities of carob are annually imported from Europe, but thus far the food has met with little favor by the American people, largely because the quality is poor and the pods too hard and dry. The carob can be softened in water, the seeds removed, and the pulp ground in a food chopper. In this form it may be mixed easily with dried fruits, such as figs, raisins or dates, to which a few chopped nuts may be added.

It is reported that trees from 25 to 30 years old yield from 450 to 550 pounds of pods annually. Large plantings of the carob tree have been made recently in Riverside County, Southern California.

CACTUS FRUIT OR PRICKLY PEAR

The prickly pear *(opuntia tuna)* sometimes called Indian fig, is found throughout California, southern Arizona, New Mexico, and northern Mexico, and is grown also in Italy, Sicily and northern Africa. It is a purplish fruit, having a succulent, juicy pulp. The spines, covering the skin of the fruit, can be burned off easily by means of a candle flame. The fruit is eaten in large quantities by the Indians and Mexicans. The composition is:

Water	79.2	per	cent	Sugar	11.7	per	cent
Protein	1.4	"	"	Fiber	3.7	"	"
Fat	1.3	"	"	Mineral Matter	2.7	"	"

A distinction should be made between the prickly pear and the smooth, spineless fruit, which is superior in quality, as well as unarmed with prickles, and, therefore, readily handled and eaten. Luther Burbank, of Santa Rosa, California, has undertaken a great deal of special work with the cactus, both for fruitage and forage

THE FEIJOA
(See page 219)

THE CHERIMOYA (CUSTARD APPLE) (see page 207)

purposes, and his remarkable success has attracted widespread attention.

THE CHERIMOYA (CUSTARD APPLE)

The cherimoya *(annona cherimola)* belongs to the family of tropical fruits, called "annonas," composed of more or less coherent fleshy carpels, or parts. About fifty species are known, several of which are widely cultivated, but the fruit has not yet achieved the commercial prominence that it merits. Experience in exporting the fruit from Madeira to the United States has demonstrated that it can be shipped without difficulty. No doubt there will be an increasing demand for this wonderful fruit when a regular supply is available. Mark Twain characterized the cherimoya as "deliciousness itself." Wilson Poponoe in his "Manual of Tropical and Sub-tropical Fruits" describes it as follows:

"The fruit is of the kind known technically as a syncarpium. It is formed of numerous carpels fused with the fleshy receptacle. It may be heart shaped, conical, oval or somewhat irregular in form. In weight it ranges from a few ounces to five pounds. The surface of the fruit in some instances is smooth; in others, it is covered with small, conical protuberances. It is light green in color. The skin is very thin and delicate, making it necessary to handle the ripe fruit with care to avoid bruising it. The flesh is white, tender in texture, and moderately juicy. Numerous brown seeds, the size and shape of a bean, are imbedded in it. The flavor is sub-acid and delicate, suggestive of the pineapple and the banana."

The cherimoya seems to be indigenous to Central America and tropical South America. It is now found in many parts of Mexico, where it grows most abundantly at elevations of 3,000 to 6,000 feet, where the climate is cool and dry. The climate of Southern California in protected places, where no heavy frosts occur, is also suitable for its cultivation. In Montecito, near Santa Barbara, a number of trees are doing well and producing fruit. The cherimoya contains about 20 per cent of fruit sugar and is especially rich in potassium salts, making the fruit strongly alkaline. The acid content is very low, amounting to only 0.13 malic acid.

THE COWTREE

A rather peculiar tree may be mentioned here—the cowtree *(brosimum galactodendron)*, indigenous to tropical America, where it is known as "palo de vaca." It grows abundantly in the

Cauca Valley in the South American Republic of Colombia. It belongs to a genus of eight species of fruit-bearing trees *(brosimum)* and derives its name from a rather thick milky substance which exudes from the tree after an incision is made. This milk, which is slightly acid in reaction, resembles milk, or rather cream, more than any other substance derived from the vegetable kingdom. According to Boussingault, a French chemist, the chemical analysis of the milk is as follows:

Water	58.0 per cent
Fat (wax and other substances, liquifying at 120 degrees F.)	35.2 " "
Sugar	2.8 " "
Casein	1.7 " "
Mineral matter and organic acids	2.3 " "

The mineral matter includes a considerable amount of lime and magnesia. The milk, which is used largely by the Indians of South America, is a most palatable and nourishing food.

THE FIG

The original home of the cultivated fig *(ficus carica)* corresponds closely to that of the olive. The fig family is one of the largest in the vegetable world. Botanists have identified and described more than 600 species, but very few of these produce edible fruits. The extreme ease with which it can be cultivated from cuttings, its resistance to heat and drought, its early bearing, its value as human food, had in the early ages much to do with its wide dissemination.

The fig occupies a unique and peculiar position among the fruits. It is really what is known to botanists as a receptacle, upon the inner surface of which are arranged hundreds of flowers, which are, therefore, hidden from the outer world. In the case of the Smyrna fig, these flowers are unisexual, and the female flowers depend for pollination on the fig wasp *(blastophoga)*. As it is necessary to shelter the fig insect the whole year round, nature has wisely provided that the *capri fig* trees bear through the winter on their leafless branches the so-called winter generation, or *mamme capri figs,* from which the fig insects issue forth in early spring.

The fig, like nearly all the semi-tropical fruits which are now cultivated in Europe and America, appears to have originated

somewhere in western Asia. Almonds, nuts, apricots, peaches, olives, Asiatic grapes, dates, figs, prunes, etc., all seem to have been brought to great perfection in Asia, several thousand years before the Christian era. Traces of a very ancient and remarkable civilization have been found existing about ten thousand years ago in the valleys of the Euphrates and Tigris. Here appear to have originated all our best fruits, nuts, vegetables and cereals, on which the western world now depends so much for its sustenance.

From Asia the fig was carried to the shores and the large islands of the Mediterranean Sea. Toward the end of the Roman Empire, at the close of the fifth century, the fig was well distributed as far as the Atlantic Coast, the Channel Islands, and perhaps over some favorable places of southern England. But nowhere else had the cultivation and drying of figs reached so high a degree of development as in Syria, and some parts of western Asia Minor.

Through the far East the fig is supposed to have reached China during the reign of the Emperor Tschang-Kien, who fitted out an expedition to Turan in the year 127 A. D. The fig has been mentioned by Chinese writers in the eighth century.

With the discovery of the New World, the edible fig obtained a foothold in all the countries visited by the Spanish and Portuguese missionaries. Figs of different and distinct species were found by them, growing in the tropical parts of Mexico, Central America, and South America, but these native figs were inferior to those brought over the Atlantic. It is to these Spanish missionaries that we owe the introduction of figs into California, and the *Black Mission Fig* is still one of the most important and widely distributed varieties in all the American countries visited by the missionaries from Spain. The Black Mission fig, which was originally planted in an isolated way as a shade tree near farm houses, is now cultivated in large commercial orchards, principally in the interior valleys of California. The tree is a very prolific bearer, and its fruit is becoming more popular every year. Indeed, few fruits are so well balanced in food principles, so rich in blood building elements as are black figs. Chemical analysis shows a remarkable similarity between the composition of human milk and the fresh fig, especially in regard to the proportion of the organic salts.

The Smyrna Fig was first introduced into California in the winter of 1881, when 14,000 cuttings, including several of the best varieties, were imported by the San Francisco Bulletin Company. A large number of the cuttings was distributed to 3,000 country subscribers of the Bulletin, while individual shares went to the different partners in the enterprise, notably Governor Stanford. Most of his cuttings are on his ranch near Vina, California, now the property of Stanford University. Large trees of both types are still growing on the place, and have furnished the source of supply for thousands of cuttings distributed by the Department of Agriculture.

The Smyrna Fig orchards of the San Joaquin Valley are made up mostly of varieties introduced by G. C. Roeding of Fresno, in 1888, when an orchard of sixty acres was planted. On account of the lack of capri figs furnishing wasps, this orchard was maintained at a loss for several years, the first commercial crop being harvested in 1900, following the successful introduction of fig wasps the previous year. Since then, large orchards have been established in the Sacramento and San Joaquin valleys. Solid plantings of several thousand acres have been made between Fresno and the San Joaquin river. Large acreages have also been planted in Tulare, Merced, and Stanislaus counties.

Before the Smyrna fig was established in California, the *White Adriatic Fig* was the most common variety. It was usually planted as a border tree along the roadsides, seldom in orchard form, and was the only commercial fig before the virtues of the Black Mission fig became better known. The Adriatic fig is smaller than the Smyrna, and contains less sugar. The fruit flesh has a light strawberry color, while the skin is greenish, turning into light yellow and brown during the drying process. Like most of the common figs, the Adriatic can be caprified, which increases its weight and sweetness. Many varieties of Adriatic figs are already cultivated successfully throughout the Gulf states, chiefly for home consumption, preserving and canning. The home fruit garden in these states usually contains a thrifty tree, which provides for the family a liberal supply of fresh figs during the summer months. The varieties in most general cultivation are the Celeste, Magnolia, Ischia, Brunswick, and Brown Turkey. The Celeste fig is the favorite in Louisiana, especially in the vicinity of New Orleans.

Another variety of figs that has lately come into prominence in

California, is the *Kadota Fig.* Honor and credit for the discovery of this remarkable fig, which is distinctly a California creation, belongs to the late Stephen H. Taft, of Sawtelle, a member of the Centenary Club of Southern California. The original tree of this variety, then unknown, discovered and named by Mr. Taft, and afterward distributed by him, first appeared in an orchard grown by Mr. Cyrus Way of Whittier, near Los Angeles. In the orchard of Dottato figs grown by Mr. Way, was one tree of most remarkable vigor, growth and early production, and in every respect superior to the balance of the orchard surrounding it. The discriminating judgment of Mr. Taft immediately recognized in this stranger, the very qualities and virtues so long sought by all progressive fig growers the world over. The advent of this fig has revolutionized the planting and pruning of fig orchards, and created a new department of labor—the skilled picking of fresh figs. While the Kadota fig is to a large extent canned at present, it can also be successfully dried, if proper precautions are taken.

The dry fig of the future will be hand picked from low-crowned, modern grown orchards and the full sugared jelly-ripe fruit cleaned and dehydrated by methods superior to sulphuring and sun drying. The finished product, semi-transparent, retaining full weight, flavor and delicacy, will be offered to the trade in tasteful and attractive cartons. Improved methods in production of all commodities have always turned out to be cheaper than crude methods, and the fig production will be no exception.

The United States annually imports from the Mediterranean countries about 10,000 tons of dried figs, valued at over one million dollars; the larger portion of these figs comes from the Smyrna district in Asia Minor. In 1920 the total production of dried figs in California amounted to about 9,000 tons, which is very small as compared with the amount of dried prunes and raisins annually produced in the state. About one-third of the California figs are of the Smyrna type, and the remainder chiefly Black Mission and Adriatic. The decrease of the importation of figs during several years of the World War, has greatly stimulated the planting of the fruit in California. When these large plantings commence to bear, this country will be independent of fig importations, especially since better methods of preparing and packing the figs for market are being constantly devised.

The fig tree, under proper care and cultivation, gives excellent returns. A ten year old black fig orchard produces as much as 5,000 pounds of dried figs per acre. A full grown Kadota fig tree produces over one hundred pounds of figs during the season.

The dried fig, if free from chemical preservatives, is one of the most wholesome and nutritious fruits for children, in place of candy, confectionery and starchy foods. It preserves the teeth, is easily digested, and prevents constipation. It is food and medicine alike, and should, therefore, be used freely in every household.

The following table shows the great nutritive and hygienic value of the black fig, compared with human milk, whole wheat and white flour.

		Human Milk	Black Figs Fresh	Black Figs Dried	Whole Wheat Bread
Water	per cent	87.75	79.00	20.00	38.40
Protein	" "	1.00	1.50	5.50	9.70
Fat	" "	3.95	0.20	1.00	0.90
Starch	" "				53.20
Sugar	" "	6.25	18.70	63.00	
Cellulose	" "			7.30	1.60
Organic Salts	" "	0.45	0.60	3.00	1.50

Organic Salts in 1000 Parts of Water-Free Substance

		Human Milk	Black Figs	Whole Wheat	White Flour
Potassium	per cent	11.73	10.50	7.20	1.82
Sodium	" "	3.16	9.60	0.50	0.08
Calcium	" "	5.80	3.50	0.75	0.43
Magnesium	" "	0.75	3.40	2.80	0.44
Iron	" "	0.07	0.60	0.30	0.03
Phosphorus	" "	7.84	6.30	10.00	2.80
Sulphur	" "	0.33	2.70	0.09	
Silicon	" "	0.07	2.40	0.46	
Chlorine	" "	6.38	1.00	0.07	
Total	" "	34.70	40.00	23.10	5.70

These figures show the remarkable similarity in the chemical composition of human milk and the fresh fig, especially in regard to the proportion of organic salts. While the percentage of fat in mother's milk is higher, the fig contains more fruit sugar, thus furnishing the same amount of heat units per ounce. It will also be noticed that the important elements of sodium, iron and sulphur

KADOTA FIG TREE IN FULL BEARING

THE SOUTHERN CALIFORNIA LOQUAT (see page 224)
(One-third Natural Size)

are contained even in larger proportion in the fig than in milk and wheat.

The growing child, on account of increasing muscular and mental activity, needs more of these elements to carry on the process of oxidation and elimination. These elements must be more frequently renewed than others, and a sufficient supply of them in our food is a matter of great importance. In all cases of physical and mental exhaustion the fig is, therefore, of exceptional value in replenishing the vital forces of the body.

THE DATE

What the cocoanut is to the inhabitants of the South Seas, the date *(phoenix dactylifera)* is to the dwellers of the deserts of southwestern Asia and northern Africa. It is but recently that oriental methods of date culture have been examined and tested by western horticulturists, especially by the United States Department of Agriculture.

In 1902 Professor Walter T. Swingle of the Bureau of Plant Industry visited the great date producing regions of Asia and Africa and secured numerous offshoots from native trees of the finer varieties. These were transplanted in the Coachella Valley, Southern California, and when the trees were large enough new offshoots were obtained for additional plantings. Professor Swingle has the result of his investigations published in an interesting Bulletin entitled "The Date Palm," from which some of the following data are taken.

The cultivation of the date is almost as old as the history of civilization. It is fully described on the clay tablets of the ancient Assyrians. It was undoubtedly one of their most important food plants and every detail of its culture, the operation of pollinating the flowers, and even the serving of the fruit at the tables of the wealthy were delineated with great accuracy in their paintings and wall sculptures.

The origin of the date palm is not known, but everything points to its being native of some of the ravines bordering the deserts of northern Africa or Arabia. It is probable that it was first cultivated by the Assyrians, afterwards by the Egyptians, and that very early its culture became almost a national industry with the Arabs.

During the seventh century, when the Arabs first invaded North

Africa, and at various intervals until the twelfth century, they introduced the use of the camel and thereby rendered it possible for the inhabitants of the oases to satisfy all their wants. By growing an abundance of dates, which the camels could carry to the more fertile regions of the Mediterranean coast countries, the Arabs could exchange their surplus product for wheat and barley needed in the Sahara for making bread. Thus the cultivation of the date palm became of great importance throughout the Sahara desert.

The Arabs consider their date palms sacred and devote as much care to them as they do to their own children. Families which own date palms are considered fortunate. The date palm is their main food supply. In fact, dates and camel's milk form the sole diet of many tribes in northern Africa and western Asia. These people have a wonderful physique and endurance, which is seldom found among the meat-eating Europeans.

The Moors undoubtedly introduced the date palm into Spain, where, in spite of the unfavorable climate, it was extensively planted during the Saracen domination. The first date palms in the New World were grown from seeds carried from Spain by the missionaries who accompanied the Spaniards on their voyages of discovery and conquest.

The possibilities of date culture in the United States were suggested by the presence of date palms in Palm Canyon, Coachella Valley, about one hundred miles southeast of Los Angeles, the only place in the country where palms grow wild. In 1922, the U. S. Government set apart Palm Canyon as a national reservation. A number of experiment stations have now been established in Southern California, Arizona, North Africa, Egypt, India and in the dry portions of Brazil, with the result that the culture of the date palm has been materially improved.

Unlike most fruit trees, the date palm has the male and female flower on separate trees. If grown from seed, about half of the resulting palms are male and half female. If such trees are allowed to grow to maturity in this proportion, enough pollen is blown by the wind to properly fertilize all the flowers. It would be, however, a very expensive method of culture to irrigate and cultivate such a large proportion of male trees. The Arabs—and before them the Assyrians—learned to pollinate the palm artificially, and with a small proportion of male trees to fertilize the flowers of a very

AN EIGHT YEAR OLD DATE PALM OF COACHELLA VALLEY, SOUTHERN CALIFORNIA.

great number of female trees. At the present time the proportion followed in commercial planting is that of about one male tree to a hundred female trees.

In all regions, however, where date culture is an important industry, the date palm is invariably propagated by removing and planting the off-shoots or suckers which spring up around the base of the trunk. These offshoots reproduce the parent variety exactly, and have the great advantage of coming into bearing sooner than the seedlings. Offshoots are produced abundantly by young date palms, but cease to form when the trees reach the age of ten to fifteen years. Usually three or four are left attached to the parent plant, any in excess of this number being cut off as fast as they form. One offshoot can be removed every year until the production has ceased. They are cut away from the parent trunk when they are from three to six years old, that is, after they have begun to develop individual roots. The leaves are removed, leaving only the bud in the center, protected by the leafstalks. No roots are left attached to the offshoot, which, when thus reduced to a mere stump, can stand much exposure.

The best time to plant offshoots is late in spring or early in summer when the ground is thoroughly warm and when there is a long hot season after planting, permitting the young palms to become well established before winter. While it is not necessary to shade the young offshoots, the ground must be kept constantly wet about their bases. The Arabs water the offshoots every day for the first forty days after planting, and then twice a week until winter. Even the older trees require a great deal of water, despite the fact that date palms are commonly associated with arid subtropical countries. In the Coachella Valley, the water is supplied from wells by electric pumps, or from artesian wells, as in the lower part of the district, and while a full crop of fruit is not produced until the palms are ten or twelve years old, they often begin bearing after they are three years old.

As the dates ripen, they pass through a series of beautiful color transformations, turning from green to reddish, then to amber or brown. The different established varieties considerably vary in this kaleidoscopic change of color; especially do the seedling dates present most delightful variations from the tones of rose and cherry, deepening to maroon and ebony black. When dates are

beginning to ripen, generally indicated by the appearance of a reddish color, the growers cover the clusters with paper bags or light cloth to protect the fruit from wasps and moths, and also to insure an even ripening and equal distribution of heat. The texture of the bags and the heaviness or lightness of the material is selected according to the type of date. The softer and juicier dates require a light material, while for the harder dates, bags of heavy crepe paper are used. These are so made that they can be opened, if desired, at the bottom to admit more air.

In the Coachella Valley, dates begin to ripen in September, and the harvest season extends to the first of December. The gardens are picked over once every week, eight or ten times in all. This is essential to ensure an even ripening of the dates in the same cluster. If the fruit were left on the tree, many dates would shrivel and become less marketable; and unripe dates are lacking in sweetness and flavor. The successful establishment of the date industry in Southern California and Arizona made it possible to supply delicious fresh dates, which formerly could be found very seldom outside of the growing districts.

The commercial value of the California date crop has been much increased by modern processing and packing the dates, so that they will keep as well as other dried fruits. The greatest demand for California dates is during the holiday season in November and December. Therefore, most of the fruit must be kept in storage for several months before being shipped. As a result of careful studies and experiments, the California date growers, assisted by horticultural experts of the government and of several western universities, are able to serve the American people with a new sort of cured date, far superior to the imported varieties in natural succulence, quality, purity and appearance. For this purpose new methods of curing and packing were put into practice, totally different from those practiced with the fruit of the Arabian deserts and Mesopotamia.

The imported varieties of dates, generally known as *Golden Dates,* are grown along the Shat-el-Arab River and are exported from Bassorah to America and Europe in enormous quantities. The principal varieties grown for export in this region are the *Halawi, Khadrawi,* and the *Sayer.* Of these the Halawi is doubtless the best; it is a medium-sized, rather light colored, sticky date,

and forms the best grade of the ordinary dates imported into America. From the region of Maskat, on the Gulf of Oman, comes the *Fard Date* of which about 1,000 tons a year are exported, mostly to America. It is darker colored and smaller than the Halawi, but brings a higher price.

The *Saidy Date* of Egypt is a variety of the first rank, adapted to commercial culture in Southern California.

The excellent and very large *Tafilet Dates* come from Morocco, where they grow in the oases east of the Atlas mountains. They are found in the markets of England, but are seen very seldom in the United States.

The *Deglet Noor* is a very late variety which requires an enormous amount of heat in order to mature properly. It does best in the interior of the Sahara, where the summers are exceedingly hot. It is mostly exported to France. Large plantings of Deglet Noors have been made in the Coachella Valley and at the Cooperative Date Gardens at Tempe, Arizona, in the famous Salt River Valley.

There are now numbers of different kinds of dates grown and packed in the California and Arizona date districts. They vary in degrees of moisture, shape and size, with a wide range of colors from light amber to glossy black to suit every taste. The date industry in the Coachella Valley and Salt River Valley has excellent prospects. Before the World War the annual importation of dates was about 20,000 tons, representing an annual per capita consumption of six ounces. This is a very small amount for a fruit with such a high food value, which furnishes a natural sweet in place of manufactured sugar and candy. There is no reason why the date should not become an integral part of our diet, since large areas in the arid southwest are well adapted to its cultivation.

Dates in their dry state consist mainly of sugar and cellulose. Analysis shows the following average composition:

Water	14.0 per cent
Protein	2.0 " "
Fat	2.5 " "
Sugar	70.0 " "
Cellulose	10.0 " "
Mineral Matter	1.2 " "

Supplemented by a few nuts and lettuce leaves, dates make a well-balanced ration. The sap of the plant provides a mild

drink, resembling cocoanut milk, which, when fermented, is known under the name of "palm wine." Date palms usually begin to bear the third or fourth year after planting, and yield a considerable return the fifth year. After the fifth, sixth, or seventh year, about 100 pounds per tree can be obtained from most varieties without difficulty. A date orchard, in full bearing, with fifty palms to the acre will yield about 5,000 pounds of fruit each year.

Growers in the Coachella valley have been able to sell all the good dates they produce at from 25c to 75c per pound. Naturally, with the rapid increase of production, these prices cannot be maintained, but even at 20c per pound, a gross revenue of $1000 per acre represents a profitable investment. Offshoots of good varieties are bringing five dollars and more, and are valuable in helping to repay the initial cost of starting a plantation.

Experienced growers figure that it takes at least $1,700 to start an acre of dates and $800 more to bring it to five years of age, when the first substantial crop may be harvested.

While the best grades of dates, when in full bearing, can be made to pay as much as $2,000 per acre, even the growing of ordinary dates, such as those sold in bulk at the fruit stands, may prove a paying enterprise if done on an extensive scale where land and irrigation are cheap.

THE DURIAN

The Durian tree *(durius zibethinus)* is a native of the Malay region. It is a large and lofty forest tree, somewhat resembling an elm in its general character, but with a scaly though smoother bark. It has oblong leaves 6 to 7 inches long, leathery in texture, shining on the upper surface and scaly on the lower. The fruit is round or slightly oval, about the size of a large cocoanut, of a green color, and covered all over with short stout spines, the bases of which touch each other, and are consequently somewhat hexagonal, while the points are very strong and sharp. It is so completely armed, that if the stalk is broken off, it is a difficult matter to lift one from the ground. The outer rind is so thick and tough, that from whatever height of the tree it may fall, it is never broken. Alfred Russel Wallace gives in his description of the Malay Archipelago an excellent idea of this remarkable fruit, which may be divided with a heavy knife and a strong hand:

"The five cells which make up the fruit are satiny white within, and each filled with an oval mass of cream colored pulp imbedded in which are two or three seeds, about the size of chestnuts. This pulp is the eatable part, and its consistency and flavor are indescribable. A rich butterlike custard, highly flavored with almonds, gives the best general idea of it, but intermingled with it come wafts of flavor that call to mind cream cheese, onion sauce, brown sherry, and other incongruities. There is a rich glutinous smoothness in the pulp, which nothing else possesses, but which adds to its delicacy. It is neither acid, nor sweet, for it is perfect as it is. In fact, to eat Durians is a new sensation, worth a voyage to the East to experience.

"It would not, perhaps, be correct to say that the Durian is the best of all fruits, because it cannot supply the place of the subacid juicy kinds, such as the orange, grape, mango or mangosteen, whose refreshing and cooling qualities are so wholesome and grateful; but as producing a food of the most exquisite flavor the durian tree is unsurpassed."

An analysis made in the Philippines by W. E. Pratt shows the fruit to contain:

Water	55.5 per cent
Total solids	44.5 " "
Protein	2.3 " "
Invert sugar	4.8 " "
Sucrose	7.9 " "
Starch	11.0 " "
Mineral matter	1.2 " "
Acids	0.1 " "

The chemical body, which is responsible for the very pronounced odor, is probably one of the sulphur compounds with some base perhaps related to butyric acid.

THE FEIJOA

The Feijoa *(feijoa sellowania)*, a native of the wilds of southern Brazil, Uruguay, Paraguay, and parts of Argentine, was introduced into southern France in 1890 by E. André, a French horticulturist, where it succeeded remarkably well. About 1900 it was introduced into California, where its cultivation has attracted much attention. The feijoa, on account of its small and soft seeds, abundance of flesh, and deliciously perfumed flavor, will no doubt find a favored place among the sub-tropical fruits now being introduced into Southern California and Florida. The shrub often

reaches a height of fifteen feet, or more. The leaves are similar in form and appearance to those of the olive. The upper surface is glossy green, the lower, silver gray. The flowers are 1½ inches in breadth, very gay and handsome. The fruit is round, oval or oblong in shape, one to three inches long, dull green in color, covered with a white bloom, and sometimes dull red on one side. The pulp of the fruit, which is surrounded by a layer of granular flesh, is translucent, jelly-like, with twenty or thirty small seeds imbedded. The flavor is suggestive of pineapple and strawberry. and, when properly ripened, the fruit has a penetrating and delightful aroma. The pulp is frequently made into jam or jelly.

The feijoa is hardier than many other sub-tropical fruits. It has, with little injury, withstood temperatures as low as 15 degrees above zero. It does well in a dry climate, if free from extremely high temperatures. If fully ripened the fruit contains:

Water	About	85.00	per	cent
Sugar	"	10.00	"	"
Protein	"	0.80	"	"
Fat	"	0.25	"	"
Min. matter	"	0.55	"	"
Crude Fiber	"	3.40	"	"

THE GUAVA

The Guava *(psidium guajava)*, like the feijoa, comes to us from tropical America, but it also does well in sub-tropical countries, like southern Spain, Florida and Southern California. The guava is a tree-like shrub. The leaves are oblong, elliptic to oval in outline, three to six inches long. Flowers are produced on branches of recent growth. They are white and about an inch broad. The fruit is round, one to four inches long, commonly yellow in color, with flesh varying from white to deep pink or salmon-red, containing numerous small hard seeds. The flavor is sweet, musky and distinctive in character, and the ripe fruit is aromatic to a high degree.

According to an analysis made by the University of California the ripe fruit contains:

Water	84.00	per	cent
Protein	0.76	"	"
Fat	0.95	"	"
Mineral matter	0.67	"	"
Fiber	5.57	"	"

THE STRAWBERRY GUAVA

The Strawberry guava *(psidium cattleianum)* originated in southern Brazil. It was probably introduced into southern China by the Portuguese. From there it was taken to the shores of the Mediterranean sea, where it now thrives in southern France, Spain and Algeria. In the United States it has been successfully cultivated in both Florida and California. The strawberry guava is ordinarily a bushy shrub, but sometimes becomes a small tree from 20 to 25 feet high. The leaves are elliptical, from two to three inches long, thick and leathery in texture, somewhat glossy, and deep green in color. The flowers are white and nearly an inch broad. The fruit is round, one to 1½ inches in diameter, purplish red in color, with a thin skin, containing numerous hard seeds. The flavor is sweet and aromatic, suggesting that of the strawberry. The fruit is often used for jelly-making. An analysis made by the University of California shows the following contents:

Water	79.42	per	cent
Protein	0.88	"	"
Fat	0.80	"	"
Fiber	6.58	"	"
Starch	6.49	"	"
Total sugar	5.06	"	"
Mineral matter	0.77	"	"

The plants come into bearing early and should produce a few fruits the second or third year after planting. The season of ripening in California is from August to October. The mature plant withstands severe frosts without injury. Temperatures of 22 degrees F. have not killed it.

THE JACK FRUIT

The Jack Fruit *(artocarpus integrifola)* which is one of the largest fruits grown in the world, often reaching a weight of from 40 to 50 pounds, belongs to the same genus of trees as the bread fruit. The tree is less exacting in regard to climatic requirements than the bread fruit tree, as it resists cool weather much better, and is, therefore, better adapted to cultivation over a wider area. The trunk of the tree attains a height of 60 to 70 feet. The leaves are oblong, oval, deep green in color, and from four to six inches in length. The flowers, which resemble those of the bread fruit

tree, are commonly produced directly on the back of the trunk and larger limbs. The surface of the fruit, which resembles in shape that of a very large water melon, and sometimes attains a length of two feet, projects directly from the trunk, and the thickest branches of the tree are studded with short hard points. The fruit is pale green in its immature state, becoming yellow and then brownish when fully ripe. Inside, the fruit is divided into many small cavities, each containing a seed surrounded by the soft pulp which is of a pungent odor and aromatic, spicy flavor, resembling that of the banana. The seeds are frequently boiled or roasted, then pulverized and used in making biscuit.

An analysis of the fruit made in Hawaii shows:

Water	76.80 per cent
Protein	5.44 " "
Sugar	15.15 " "
Fat	0.45 " "
Acids	0.27 " "
Fiber	1.30 " "

The seeds were found to contain:

Water	about 15.00 per cent
Sugar	15.15 " "
Fat	0.24 " "
Fiber	1.80 " "
Protein	5.44 " "
Carbo-hydrate (starch)	23.53 " "
Acids	0.16 " "

The tree grows wild in the mountains of India and Ceylon. It was introduced into Brazil in the seventeenth century and is now found in abundance in the region of Bahia. In the latter part of the eighteenth century, Jack Fruit trees were planted in Jamaica and are now common all over the island. To a smaller extent the tree is now grown in the Hawaiian Islands and in southern Florida. The California climate has proved unfavorable to the tree.

THE LITCHI

The litchi *(litchi chinensis)* is the favorite fruit of the Chinese. In southern China its cultivation dates back more than two thousand years. It is now grown extensively, and is familiar to millions of people, many of whom prefer it to the orange and peach, two of the finest fruits of southern China. The region

around Canton is considered the most favorable portion of China for litchi culture.

The tree grows to an ultimate height of thirty to forty feet, and forms a broad round-topped crown, with glossy, light green foliage. The fruit, which grows in loose clusters of from two to twenty, or more, has the appearance of a large strawberry, reaching a diameter of 1½ inches in the better varieties. The outer covering, which is hard and brittle, changes in color from deep rose to dark brown, as the fruit dries on the trees. When fresh the pulp of the fruit is white, translucent, firm and juicy, and has a sub-acid flavor. The litchi nut, as it is generally called in its dried state, is really a dried fruit, surrounded by a thin nut-like shell, and resembles the Muscat raisin in flavor. It is a favorite in China and has become well known in this country since its introduction by the Chinese.

When fresh the litchi contains:

Water	79.00 per cent
Protein	1.15 " "
Fat	0.20 " "
Sugar	15.30 " "
Mineral	5.40 " "

When dry this fruit contains:

Water	16.00 per cent
Protein	2.90 " "
Fat	0.80 " "
Sugar	78.00 " "
Mineral matter	1.90 " "

The fruit has an acid content of over 1 per cent. No dinner in China is complete without some of these little fruits.

Experiments have been made to introduce the litchi into Florida and Southern California. Although it has taken many years to demonstrate the possibilities of the litchi's fruiting in Florida, it is now hoped that with suitable varieties the litchi may become the basis of an industry. The first litchi tree to be introduced into California is said to have come from Florida and was planted by Mr. E. W. Hadley in Santa Barbara about 1897. This tree was obtained as a small plant from the nursery of Reasoner Brothers, Oneca, Florida. Mr. E. N. Reasoner states that this California tree was originally imported from Saharanpur, India. It first fruited in 1913. It is possible that hardy varieties

from the hill country of India may prove best adapted to California and Florida.

THE JUJUBE

The jujube *(zizyphus jujuba),* like the litchi, is one of the principal fruits of China, and has been cultivated for at least 4,000 years. The jujube is a small, spiny tree, reaching a height of twenty to thirty feet. The fruit resembles the date in size and form, often reaching a length of two inches, and is covered with a thin, dark brown skin. The flesh is whitish, of crisp, or mealy texture, and of sweet, agreeable flavor, enclosing, like the date, a hard elliptic stone.

The jujube tree can be cultivated in the interior valleys of California, if sufficiently irrigated. While a long, warm summer is necessary for the perfect ripening of the fruit, the tree has withstood temperatures of 22 degrees F.

The chemical composition of the jujube is given by the Bureau of Chemistry at Washington, as follows:

Total solids	31.90	per cent
Sugar	21.66	" "
Protein	1.44	" "
Fat	0.21	" "
Mineral matter	0.73	" "
Fiber	1.28	" "

The late Frank N. Meyer, to whom we are indebted for many fine Chinese varieties of this fruit, observed, during his explorations in China, that the jujube could be used in several different ways. The fruits of some varieties are excellent to eat when they are fresh. Dried, they resemble dates in character; they are often called *Chinese dates.* Jujubes are sometimes boiled with millet and rice. They may be stewed or baked in the oven. They are used, like raisins to make jujube bread, and they are made into glace fruits by boiling them in honey or sugar syrup.

THE LOQUAT

The loquat *(eriobotrya japonica)* is one of the sub-tropical fruits that has been recently introduced into the United States. It is a true prune fruit and is closely related to the apple, pear, quince and medlar. It has the size of a small pear, and the better varieties contain three or four large seeds. When quite ripe

the fruit is of deep yellow, and a very pleasant, acid flavor. The amount of fruit acid in the loquat is about 1 per cent, mostly malic.

The loquat has been cultivated in Japan for more than a thousand years, and grows in every district, except the northeastern part. It was introduced into California, the Gulf States, and Florida about 1880, and since that time has been grown commercially in several counties of Southern California. The tree is a very heavy bearer, and in one instance a fourteen acre orchard in Orange county, California, produced eighty tons of good fruit.

The analysis of the edible portion of the best varieties shows:

Water	85.00	per cent
Protein	0.32	" "
Fat	0.03	" "
Sugar	12.00	" "
Mineral matter	0.36	" "
Crude fiber	0.37	" "

To people living in the temperate zones and travelers in tropical and sub-tropical countries, the loquat should possess an especial attraction for it is similar in flavor and character to the fruits of the North, as it contains a good deal more fruit acid than the average tropical fruits.

Because of its ornamental appearance alone, the loquat is often planted in parks and gardens. It is a small evergreen tree, rarely more than 30 feet high, commonly not exceeding 20 or 25 feet.

THE MANGO

The mango *(mangifera indica)* is one of the oldest fruits cultivated by man in the tropical zones. The tree, being evergreen, often attains a very large spread and an age of one hundred years and more. The fruit, which is shaped like a plum, varies in size from a few ounces to several pounds in weight. The skin is smooth, and thicker than that of the nectarine, which it resembles in color. The flesh is yellow, or orange, and juicy, tasting somewhat like a combination of apricot and pineapple. The seeds are large and flattened, enclosing a white kernel.

The average chemical analysis of the mango shows:

Water	80.0	per cent	Fat	0.1	per cent
Coarse fiber	5.0	" "	Ash	0.4	" "
Sugar	13.3	" "	Acid (malic and tartaric)	0.5	" "
Protein	0.7	" "			

In the United States mangos can be grown in some of the favored foothill sections of Southern California, and in the southern part of Florida. The largest commercial plantings have been made in the vicinity of Miami, Palm Beach, and Fort Myers, where, during the winter heavy frosts seldom occur.

The horticultural varieties of the mango are numerous, amounting to several hundred. Many of these, however, are of limited distribution and little importance. The cultivated mangos are usually considered of a single species, mangifera indica.

THE MANGOSTEEN

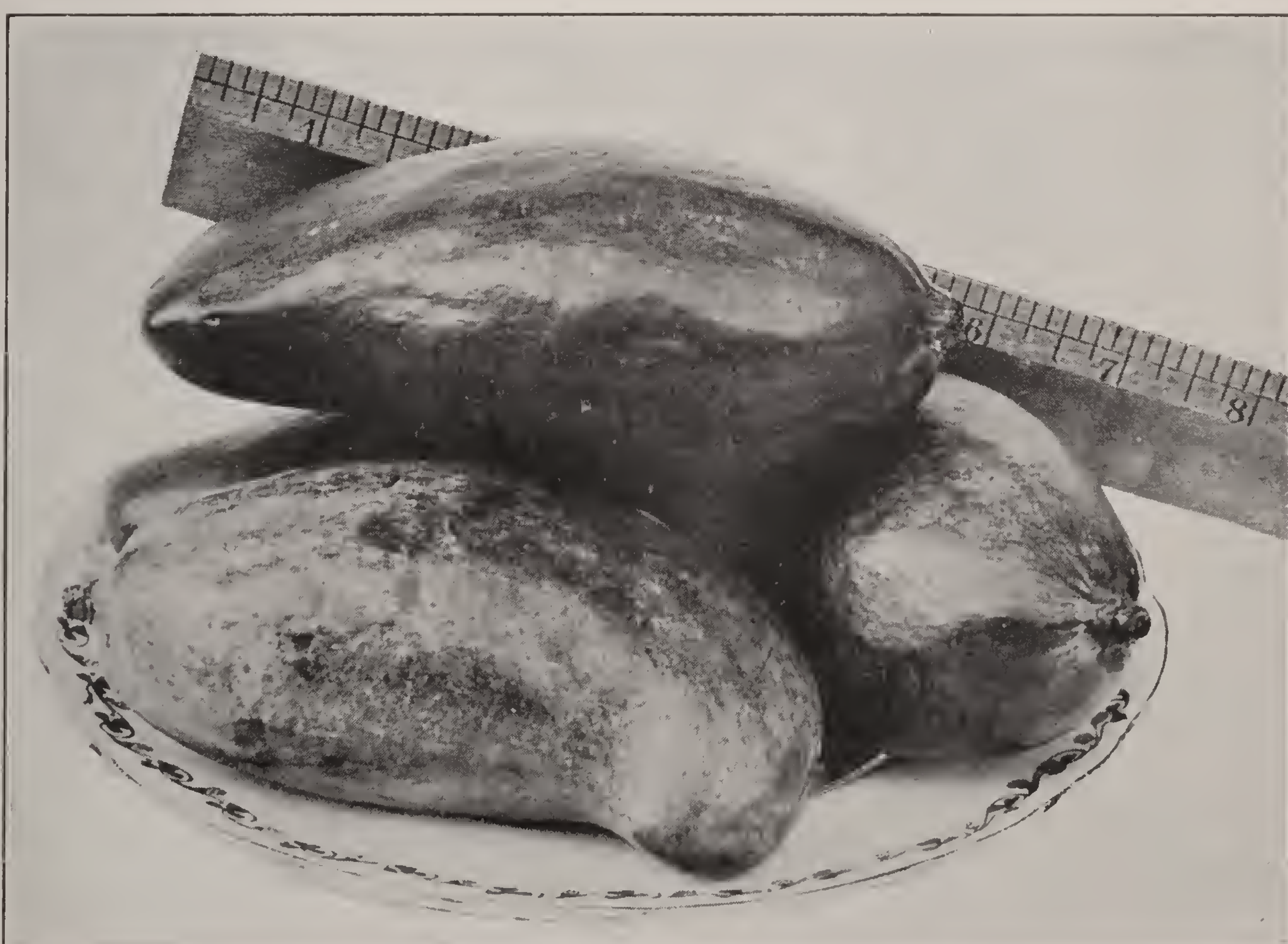
The mangosteen *(garcinia mangostana)* is a delicious fruit about the size of a mandarin orange, round and slightly flattened at each end with a smooth, thick rind of rich red-purple color, with here and there a bright, hardened drop of the yellow juice, resulting from some injury to the rind when immature. It has been termed "the finest fruit in the world," on account of its beautiful coloring, combined with a most delicate and luscious flavor. It is extensively grown in the East Indies, particularly in Java and Sumatra, but a number of trees have now been planted in Cuba, Porto Rico, the Canal zone, and lately in some of the Central American countries. Like the bread fruit, and a few other strictly tropical species, it does not thrive in places where the temperature falls below 40 degrees F.

It contains about 12 per cent sugar, and is rich in alkaline elements. The rind, or the entire fruit, dried, is used medicinally in India. It contains some tannin, and a crystallizable substance known as "mangostin."

Although the mangosteen is a very delicate fruit, it has an exceedingly tough, thick rind, and on this account it is likely to be good for shipping. Fruits which were sent to Washington from Trinidad, were excellent when eaten twenty-one days later, even though they had been out of cold storage over a week. It requires a circular cut with a sharp knife to lift the top off like a cap, exposing the white segments, five, six, or seven in number lying loose in the cup. Professor Fairchild, a noted explorer says of the qualities of the fruit:

"The texture of the mangosteen pulp much resembles that of a well ripened plum, only it is so delicate that it melts in the mouth like a bit of ice cream. The flavor is quite indescribably delicious."

THE WHITE SAPOTE (see page 235)



THE MANGO (see page 225)

THE MAMEY

The mamey tree *(mammea americana),* which is related to the mangosteen, is one of the most beautiful and conspicuous in the West Indies, reaching a height of sixty feet. Its trunk sometimes attains a diameter of 3 or 4 feet, while the crown is of a deeper and richer green than that of most other trees. The leaves are oblong in form, rounded or blunt at the apex, 4 to 8 inches long and thick and glossy. The white flowers, which are solitary and clustered in the axils of the young shoots, are fragrant and about an inch broad. The fruit is oblate or round in form and commonly 4 to 6 inches in diameter. It has a slightly roughened russet surface and a leathery skin about ⅛ inch thick. Surrounding the one to four large seeds, and often adhering to them, is the bright, yellow, juicy flesh with a subacid and pleasant flavor, resembling that of the peach.

Outside of its native region, it is grown in Mexico and Central America. It is also successfully cultivated in Florida as far north as Palm Beach, but the mamey is strictly tropical in its requirements, and cannot be grown in regions which commonly experience frost. The ripening season is in the summer.

THE OLIVE

The cultivation of the olive *(olea europaea)* goes back into the beginning of ancient history. Olives were grown by the Egyptians four thousand years ago. It was a favorite fruit with the ancient Hebrews, Greeks, and Romans.

It was first introduced into California from Mexico in 1769 by an expedition of Franciscan monks, sent to take charge of the Jesuit missions. The first seeds of the olive are said to have been planted at the Mission San Diego, where they grew and prospered. As the Fathers built new missions, the olive was always among the trees first planted, cuttings having been supplied from the San Diego Mission. The Mission orchards were small, but they laid the foundation of the present olive industry of California, which represents about forty thousand acres, or nearly two million trees, averaging about fifty trees per acre.

The principal varieties grown are the Mission, Columbella, Manzanillo, Nevadillo, Picholine, Sevillano and Ascolano. The last two named are the largest varieties grown.

The large sized olives are used for pickling, and the smaller ones for oil extraction. In both cases some of the nutritive elements of the natural ripe olives are lost. Only in the fully ripened sun-dried olives are all the nutritive principles of the olive preserved, and, although they still retain some of the bitter taste, which is very pronounced in the matured olives while on the tree, they are undoubtedly more wholesome than the pickled olives. In the pickled product the bitterness is neutralized by the application of lye solution.

At the Agricultural Experiment Station of the University of California, Berkeley, the following process for pickling ripe olives is generally used:

1. Place the olives in a solution composed of two ounces of potash lye to one gallon of water for four hours. Repeat this once or twice, if necessary, sufficiently to remove the tartness.
2. Rinse the olives thoroughly and replace the lye solution with fresh water. Change the water twice daily, or until the potash has been removed from the fruit, as judged by the taste.
3. Replace the water with brine composed of four ounces of salt to a gallon of water, and allow to stand two days.
4. Put in brine of six ounces of salt to a gallon of water for seven days.
5. Put in brine of ten ounces of salt to a gallon of water for two weeks.
6. Finally put into a brine containing fourteen ounces of salt to the gallon.

The best pickled olives are made without the use of lye, but this process is practicable only with varieties such as the Ascolano and Columbella, the tartness of which is more easily removed, especially when the water is soft and plentiful. Even then it is a very slow and tedious process. It differs from the former method quoted only in an elimination of the lye. The olives at the outset are put in pure water, which is changed twice a day until the bitterness is sufficiently extracted. This requires from forty to sixty days, or more.

The best oil is made by crushing the carefully picked olives as soon as possible after they are gathered, and while they are still perfectly fresh. If they are bruised, or in the slightest degree moldy when crushed, the resulting oil will be of correspondingly inferior quality.

The extraction of oil from fresh olives, however, is somewhat troublesome, and in order to facilitate the work it is customary to deprive them of a certain portion of their water before crushing. This partial drying is also useful when it is necessary to keep the fruit for some time before crushing, or to ship it long distances. In order to hasten the process dehydraters are sometimes used. The olives are placed in a single layer on trays, and the dehydrater is kept for about twenty-four hours at a temperature of about 125 degrees F. The olives must be crushed immediately upon removal from the dehydrater.

Ripe olives are composed on an average of:

Water	96.6 per cent
Fat	21.0 " "
Mineral matter	3.4 " "
Protein	2.0 " "
Carbohydrates	4.0 " "

The mineral matter is very rich in the basic elements of potash, lime, magnesia and iron.

Dried olives contain as much as 5 per cent protein and 50 per cent fat, and are equal to nuts in nutritive value. If combined with sweet fruits, they make a palatable, wholesome combination.

THE PAPAYA

The papaya *(carica papaya),* often called tree melon, is a giant herbaceous plant rather than a tree, and grows to a height of 25 feet, without lateral branches, but producing deeply lobed leaves at the top. The fruit strongly resembles a melon, and attains a length of from three to eighteen inches, sometimes weighing as much as 20 pounds. The skin is thin and smooth, orange yellow to deep orange in color. The flesh is from one to two inches thick, of a somewhat deeper color than the skin, enclosing a large cavity, to the walls of which numerous round, blackish seeds are attached. The taste is rather sweet, with a slightly musky flavor. In nearly all parts of tropical America it is one of the common fruits. It is extensively cultivated in Hawaii, and is also successfully grown in the southern part of Florida.

A composition of the papaya, grown near Honolulu, shows:

Sugar	10.29 per cent
Protein	0.50 " "
Fat	0.50 " "
Acid	0.07 " "
Mineral matter	0.56 " "
Fiber	0.76 " "

THE POMEGRANATE

The pomegranate *(punica granatum)*, like the fig, vine and olive, has been grown since the earliest times. It is mentioned in ancient Grecian history, antedating the founding of Rome. Later on, frequent mention is made of it by Roman writers. Granada, in Spain, owes its name to its excellent pomegranates. Subsequent to the conquest of Mexico by the Spaniards, all the fruits from old missions in Mexico were carried northward and planted in the new mission gardens of California. Since 1850 new varieties have been introduced, mainly from European countries and China.

The pomegranate is also valued as an ornamental tree on account of its bright, glossy, green leaves and the profusion of its beautiful blossoms. The ripe fruit measures from three to six inches in diameter, and contains a variable number of small, angular, berry-like fruit bodies, the angularity being caused by their large number packed closely together. Each of these fruit bodies is covered with a membrane, enclosing a fruity mass, very rich in juice. The rind, enclosing the fruit bodies, is tough and leathery and varies in color from pale yellow to deep, purplish red.

Analysis of the fruit by the California and Hawaiian Agricultural Experiment Stations show the composition of the edible portion as follows:

Water	76.8 per cent
Protein	1.5 " "
Fat	3.0 " "
Sugar	14.0 to 16.0 " "
Crude fiber	3.0 to 4.0 " "
Mineral matter	0.6 " "

The acid content, chiefly citric, ranges from 0.6 to 1 per cent, or similar to that of sweet strawberries. The sweet pomegranate

possesses a delicate fresh crispness of flavor, almost unrivaled among fruits. As yet the demand for pomegranates is not very large, due to a lack of knowledge on the part of the public as to the merits of the fruit.

THE PERSIMMON

This delicious fruit comes to us from China and Japan, where several hundred varieties are cultivated. Persimmons belong to the Ebony family, and to the genus *diospyros*, from the Greek words, *dios* and *pyros*, suggestive of the life-giving principles of the fruit. The Japanese consider it to be one of their best fruits, while the Chinese also value it highly and devote large areas to its production. The first trees were brought to the United States in 1870, and at present there are a number of commercial orchards in Southern and Central California, besides many trees found in home orchards. There is no doubt that it will soon assume an important position among the orchard fruits of California and the Gulf States.

The fruit in size and color somewhat resembles the tomato. It has a thin, membranous skin, enclosing a soft, reddish pulp of very sweet and pleasant flavor, in which are imbedded from four to eight elliptic, soft, flattened, dark brown seeds, although seedless fruits are found frequently. The astringency of the unripe persimmon is due to the presence of soluble tannin, which disappears in the ripening process.

The season of the persimmon extends from October to January. Chemical analysis shows that the edible portion of the fruit contains on an average:

Water	80.21	per cent
Protein	1.36	" "
Sugar	15.13	" "
Fat	0.57	" "
Crude fiber	2.08	" "
Mineral matter	0.65	" "

In Japan certain varieties are used extensively for drying. The finished product somewhat resembles the dried fig in character and is almost as delicious. They are picked with a bit of stem attached, peeled, tied together by the stems with string and hung up to dry, a process requiring about three weeks. After this they are sweated for a few days. This causes a heavy coat-

ing of sugar to crystallize on the surface, the resultant product being a pleasing sweetmeat and a wholesome confection. The fresh fruit has brought so high a return in California that growers have not bothered to dry it. With the increase in plantings, it is probable that this practice will become a lucrative one.

The Northern California fruit is practically all shipped out, there being no local demand. Hawaii, San Francisco and New York consume all that is produced. In Southern California, the local markets in Los Angeles and neighboring cities take all the fruit that is grown.

Based on the experience of growers, mature, bearing orchards will yield, under good care and management, from twelve to fifteen tons of fresh fruit per acre a year, depending upon variety and the distance apart the trees are set in the orchard. A forty-year-old Maru tree on the property of J. B. Adams at Newcastle, California, has borne as much as 800 pounds of fruit in one year, an exceptional figure not to be taken as a basis for normal orchard returns. Two acres on the same place, at about ten years of age, have yielded as high as $1,380. The price received for persimmons has been uniformly good for many years, averaging from 6 to 7 cents per pound. For extra fine Hachiya fruit, a grower in Orange county, Southern California, has received 12½ cents per pound on the ranch.

THE PINEAPPLE

The pineapple *(ananas sativus)* is a multiple fruit, an aggregate of many small individual fruits, the number of which determines the size of the pineapple. At a certain period of the growth of the plant, the center, or the last-formed leaves, assumes a bright red color, and instead of forming more leaves, the flowerhead appears on a stalk, which is a direct elongation of the plant stem. The flowers, which are small, are of a violet or purple color. In the further growth the flowerhead loses its bright red color, and the terminal leaves form the rosette, or crown, that is on top of the fruit. Later, buds may appear on the stem below the fruit which develop into slips. The plant bears but one fruit, and the next crop must be produced by a new set of plants. The leaf of the pineapple plant, which attains a length of about two feet, in some varieties is nearly smooth, while in

others the margins are covered with spines, evidently intended by nature as a protection against insects. For cultivation, however, the spineless is far preferable.

About 10,000 plants can be grown on a well cultivated acre of land, which will on an average yield 9,000 fruits, from 3½ to 5 inches in diameter, and from 6 to 8 inches long, weighing from 2 to 4 pounds each.

Most of the fruit is picked quite green for canning purposes, but the more nearly ripe the pineapple is allowed to become before gathering, the better its flavor and the higher its sugar content will be. Some of the fruit cut when immature may ripen, but the quality will not improve.

Ripe pineapples contain on an average:

Water	85.00 per cent
Protein	0.50 " "
Sugar	13.00 " "
Mineral matter	0.30 " "

In the latter the elements of potassium, calcium and magnesium predominate.

THE SAPODILLA

The sapodilla *(achras sapota)* is one of the best of tropical fruits. It is grown abundantly in the lowlands of Southern Mexico, Tabasco, Chiapas, also in Guatemala, San Salvador and Honduras. It is also found on the western coast of India, in Bengal and Ceylon. In the most southern part of Florida and on the Florida Keys many trees have been cultivated successfully.

The fruit is variable in form, commonly round, and is from 2 to 3½ inches in diameter. It has a rather thick skin, is brown to greenish brown in color, granular in texture, and very juicy. It has a characteristic odor and flavor, and is very sweet. The seeds are from nine to ten, or twelve, in number, and are hard and black and about three quarters of an inch in length. They are easily separated from the flesh.

A chemical analysis of the fruit gives the following figures:

Water	75.00 per cent
Protein	0.87 " "
Fat	0.55 " "
Sugar	20.00 " "
Mineral matter	1.00 " "
Fiber	1.60 " "

The sugar is composed of saccharose, dextrose and levulose. The sapodilla is rich in potash, lime and chlorine; it also contains a small amount of acid.

The common name *sapodilla,* by which the fruit is known in Florida, is taken from the Spanish *zapotillo,* meaning small *zapote.* In Mexico the usual name is *chicozapote,* often abbreviated to *chico.*

Experiments have shown that the fruit can be shipped successfully, if properly packed. The skin is thin and delicate and the fully ripe fruit is injured very easily; but if picked while still firm in texture, it does not begin to soften for several days.

THE SAPOTE

The sapote *(calocarpum mammosum)* is another of the important fruits of Central American lowlands. It is this fruit that is said to have kept Cortez with his army alive on his famous march from Mexico City to Honduras. The tree often attains a height of 60 feet and more, with a thick trunk and short branches. The fruit is oval in form, from three to six inches long, and has a thick and woody skin of russet brown color. The flesh is firm, salmon pink to reddish-brown in color, and finely granular in texture. The large elliptic seed can be removed as easily as that of a free stone peach or avocado.

In chemical analysis it resembles the sapodilla, but it is sweeter, and lacks acid.

Outside of its native area, the sapote is grown in the West Indies, South America, and in the Philippines. In Cuba it is particularly abundant and the fruit is highly esteemed. Experiments in cultivating the sapote is southeastern Florida have not been successful. In the different districts the fruit is known under various names. In the French West Indies it is known as *grosse sapote,* in Cuba as *mamey colorado,* in southern Mexico and Central America as *zapote,* (derived from the Aztec name, *tzapotl*) and in the Philippines as *chico-mamey.*

The Green Sapote *(calocarpum viride),* common in the Guatemalan highlands, is also found in Honduras and Costa Rica. It is superior in flavor to its congener the sapote, but it is much more limited in its distribution.

THE WHITE SAPOTE

The white sapote *(casimiroa edulis)* is a common fruit of the Mexican and Central American highlands where it ranks among the principal cultivated fruits. Outside of this region it is not well known, although, in recent years, it has to a small extent been cultivated in Southern California and Florida.

The tree is medium-sized, erect or spreading, having palmately compound leaves, small inconspicuous flowers and yellowish-green fruits, the size of an orange. The fruits have a thin membraneous skin, yellowish flesh of soft melting texture, sweet or slightly bitter flavor, and one to five large oval elliptic seeds.

An analysis of the fruit made at the University of California shows it to contain:

Water	74.74	per cent
Protein	0.87	" "
Total sugars	21.75	" "
Fat	0.55	" "
Starch	1.62	" "
Mineral matter	0.47	" "

THE SOUR-SOP

The sour-sop *(annona muricata)*, Spanish *guanabana,* is a small tree, slender in growth and rarely more than 20 feet high. It is strictly tropical and succeeds best in the tropical lowlands. The leaves are elliptic in form, commonly 3 to 6 inches long, leathery in texture and glossy. The fruit is the largest of the annonas, varying from 3½ to 12 inches in length. Specimens weighing five pounds are not uncommon, and much larger ones have been reported. It is heart-shaped or oblong conical in form, deep green in color, with numerous short spines on the surface. The skin has a very bitter flavor. The flesh is white, having the appearance of wet cotton, but very juicy and highly aromatic. Numerous brown seeds, much like those of the cherimoya, are embedded in it. The flavor suggests that of the pineapple and the mango. The fruit is highly esteemed for making cooling summer beverages. In the West Indies a very popular drink *Champola de Guanabana,* is made by macerating the fruit with sugar, diluting with water, and straining off the pulp.

The chemical analysis of the edible portion of the fruit shows on an average:

Water	80.00	per cent
Protein	1.65	" "
Fat	0.50	" "
Sugar	14.00	" "
Fiber	1.50	" "
Mineral matter	0.86	" "
Acid	0.50	" "

The sour-sop is indigenous to the West Indies, as well as to the mainland of South America. At present it is more popular in Cuba than in any other part of the tropics. In the United States, it can be grown only in southern Florida, where with the proper protection it thrives at Miami and even as far north as Palm Beach. The tree, if grown from seed comes into bearing when three to four years old.

THE SWEET-SOP

The sweet-sop *(annona squamosa)*, also called sugar-apple, does not attain the size of either the sour-sop or the cherimoya. The tree is also smaller than that of most other species of the annonas, its maximum height being 15 to 20 feet. The fruit is round, heart-shaped, ovate or conical, 2 to 3 inches in diameter, and yellowish in color. The surface is tuberculated and covered with a whitish bloom. The pulp is white, custard-like, sweet and slightly acidulous in flavor, but it is not equal to the cherimoya in deliciousness. The carpels, each of which normally contains a brown seed, the size of a small bean, cohere loosely or not at all, differing in that respect from the cherimoya, in which it is difficult to distinguish carpellary divisions in the flesh.

The chemical composition of the sweet-sop is similar to that of the cherimoya. Alice R. Thompson, who has analyzed the fruit in Hawaii, has found it to contain:

Water	75.12	per cent
Protein	1.53	" "
Fat	0.54	" "
Total sugars	18.15	" "
Fiber	1.22	" "
Mineral matter	0.80	" "
Fruit acids	0.12	" "

The sweet-sop is indigenous to tropical America. It also grows abundantly in India. It is a popular fruit in the lowlands of Mexi-

co. It is likewise found in the Philippines and Hawaii. In Australia it is grown throughout a considerable part of coastal Queensland. It has been grown successfully in southern Florida, from Punta Gorda on the west coast and Palm Beach on the east to Key West.

THE STAR-APPLE

The Star-apple *(chrysophyllum cainoto)* is a common dooryard tree in the West Indies. It is popular in Cuba where it is also cultivated for its ornamental value. On the deep, rich soils of the Island, the tree sometimes reaches 50 feet in height, although in southern Florida, it rarely exceeds 30 feet. The leaves are oval about four inches in length, deep green and glossy above, and golden brown, with a sheen like that of satin, beneath. The small flowers are purplish-white in color. The fruit attains the size of a small apple, averaging 7 ounces in weight. The surface is smooth, somewhat glossy, dull purple in some varieties, light green in others. It has two distinct kinds of pulp; the inner one, a white gelatinous mass containing the small black seeds, is the edible portion, constituting only one-third of the fruit, the outer fibrous purple portion not being very palatable. When the fruit is cut in halves, the segments present a star-like appearance, hence the name. Both kinds of pulp are sweet, but are lacking in acidity. An analysis made by Alice R. Thompson in Hawaii shows the ripe fruit to contain:

Water	88.50	per	cent
Protein	2.35	"	"
Fat	1.38	"	"
Total sugars	4.40	"	"
Fiber	0.85	"	"
Mineral matter	0.40	"	"
Acids	0.12	"	"

The tree grows wild throughout the West Indies and in Central America. It is also cultivated in these countries, as well as in South America, Mexico, southern Florida, and to a limited extent, in Hawaii.

THE TAMARIND

The tamarind *(tamarindus indica)*, like the carob, is the fruit of a leguminous tree. The fruit is a dark brown pod, from one to six inches long and from three-quarters to one inch in width. Small indentations on the pod roughly mark the location of the

seeds within. The exterior skin is thin and very brittle. Within there is a thick, dark-colored pasty material closely surrounding the seed sacks and joined to the stem of the pod by several coarse fibers. This paste constitutes the edible portion of the fruit, and is so intensely sour in taste that the 30 per cent or more of sugar it contains is entirely masked and can be detected only by a slightly sweet after-taste. In fact, the tamarind is remarkable in that it contains a very high content of both acid and sugar. The composition, according to Dr. Wiley, is as follows:

Water	47.70 per cent
Protein	1.36 " "
Sugars	31.43 " "
Mineral matter	1.56 " "
Acids	6.03 " "

The content of silicon is especially high.

The fruit is imported mostly from the East and West Indies, and is used in making refreshing summer beverages. Tamarind whey is made by mixing one ounce of the pulp with one and one-half pints of warm milk, and is a palatable and nourishing beverage.

The tamarind is a native of tropical Africa and Southern Asia. It has long been cultivated in India and was easily introduced into tropical America. It has been successfully grown in southern Florida, and as far north as the bay region of Tampa.

CHAPTER III

NUTS

Next to fruits, nuts are the most essential foods in a well-balanced and wholesome diet. Nuts are highly nutritious, in fact, they are the most concentrated foods of nature, in their dry state containing on an average:

Water	5.	per cent
Protein	20.	" "
Fat	50.	" "
Mineral matter	2.	" "

With the exception of the chestnut, nuts contain but a small percentage of starch. As in all seeds, the mineral matter of nuts contains a large amount of phosphoric acid, potash and magnesia, while they are deficient in sodium, lime and chlorine. They should, therefore, always be eaten with fruits or green leaf vegetables to make up for this deficiency.

Nuts are often used as a dessert after a heavy meal. In this case they are harmful, as they require the full action of the digestive juices. Combined with fruits or vegetable salads, nuts make a complete meal in themselves, and their indigestibility in most cases must be attributed to lack of wisdom in the choice of food eaten with them. If nuts are thoroughly masticated and used in small quantities, and well combined, they are easily digested and utilized by the human body.

Attention has been directed to some interesting experiments of Professor Myer E. Jaffa, of the University of California. The nutritive value of the fruit and nut diet was demonstrated most clearly with a young University student, who, though entirely unaccustomed to such fare, gradually changed from an ordinary mixed diet to one of fruit and nuts, without apparent loss of health or strength. He was then able for eight days to perform his usual college duties, and during a part of the time to perform heavy physical work on exclusive fruitarian diet, without material loss of weight.

It should also be mentioned here that in all cases where the

diet was limited in variety, consisting of combinations of only one or two fruits with one kind of nuts, the subject complained of a constant craving for something else such as green vegetables or cereals. At such times it was found that the coefficients of digestibility were lower than those recorded when he ate vegetables, or cereals, which made the diet more appetizing.

Scientific investigations prove that all the nuts, especially in the form of unroasted nut butter, furnish a relatively high amount of basic amino acids, and that nut proteins are of a high biological value. The investigators observed normal growth and sleek appearance of young rats on diets in which the cocoanut and peanut furnished the sole source of protein. Osborne and Mendel have maintained rats for long periods, in which the protein of the dietary was derived from the Brazil nut.

Professor F. A. Cajori, who conducted a number of experiments at the Sheffield laboratory, Yale University, observed satisfactory growth in young rats on diets in which the almond, English walnut, filbert, and pine nut, respectively, furnished the essential source of protein in the ration.

Normal growth can be secured when rats are fed upon otherwise adequate diets, containing the almond, English walnut, black walnut, Brazil nut, chestnut, or pecan, as the sole source of water soluble vitamin. Animals that have declined on a diet devoid of water soluble vitamin, promptly recover when the almond, English walnut, filbert, hickory nut, pine nut, chestnut and pecan were introduced. These observations indicate that nuts are sources of abundant quantities of water soluble vitamin. The protein of the almond, English walnut, pine nut, or filbert, furnishes the necessary nitrogenous compounds for the elaboration of milk in female rats.

Likewise, Professor Hoobler has concluded from his experiments that diets containing almonds, English walnuts, pecans and peanut butter as a source of protein, are as suitable for milk production as diets which furnish protein from animal sources. In other words, nuts seem to furnish the nitrogenous compounds necessary for milk elaboration as effectively as any other type of protein. Furthermore, nuts or nut butter, made from the unroasted whole nut, furnish us the necessary proteins and fats combined with organic salts in the purest form, and, therefore, are superior

to the extracted or isolated fats, whether of animal or vegetable origin.

These conclusions are confirmed by Professor Cajori, who found in his metabolic experiments on a number of men, that the proteins and fats of nuts were generally absorbed to a large extent. In no case did the quantity of nitrogen or carbohydrates in the feces indicate that these nuts are especially resistant to the digestive functions of the alimentary canal when the nuts were eaten in an emulsified form, as nut butters.

Emulsification of nuts is artificially obtained by machinery to a degree reached only by the most careful mastication. As most people have more or less defective teeth, it is seldom that the entire edible nut is reduced by mere mastication to such a state as to contain no hard particles when it enters the stomach. Even small particles of such concentrated foods as nuts are not easily penetrated by the digestive juices, and, consequently, delayed cleavage of these particles, which often pass undigested through the alimentary canal. Experiments have proved that the coefficiency of digestibility is from 5 per cent to 10 per cent higher in nut butter than in whole nuts, even if well masticated.

While people who have defective teeth should use nuts in the form of nut butter, in which the fats are brought into a state of emulsion, attention should be paid to the fact that nut butters are frequently made from highly roasted nuts, which contain free fatty acids and are often heavily salted. Such preparations are not wholesome, as they overtax the liver and kidneys. Nuts that enter into the preparation of nut butters should be dried, or evaporated, at a temperature of not more than 160° F. to preserve the vitamins and to remove sufficient moisture to make the nuts crisp. In this condition the nuts can, by means of a nut mill, be converted into a smooth butter, which is easily assimilated and is superior in nutritive value to flesh food and dairy butter.

Recently there have been put on the market different varieties of salted nuts. There appears to exist a popular belief that salt with nuts prevents the digestive disturbances often arising from eating them at inopportune times. To those who have acquired the salt eating habit, nothing seems palatable without the addition of this condiment, but no proofs have been forthcoming which demonstrate that the digestibility of nuts is improved by the use of salt.

On the contrary, salt retards the digestion of nuts or, indeed, any food.

The real nut butters, manufactured from the entire nut, must be always distinguished from the so-called margarine butters made of vegetable oils, such as coccanut, peanut and cottonseed oils, which are extracted and purified fats with the addition of some skim milk and about three per cent of salt, and sold under various trade names. Such products may be used occasionally in culinary ways, but they can by no means take the place of the tissue-building nut butters, made from the entire nuts and containing the organic salts and vitamins necessary to promote growth.

The total amount spent for nuts by the inhabitants of the United States is still very small compared with the amounts spent for meats, cereals and dairy products, owing largely to the fact that people have not yet learned the proper use of these most concentrated food products of nature. Of the fifty million dollars paid annually for nuts, about thirty-five million dollars' worth are imported, and only fifteen million dollars' worth grown in the United States. There are great possibilities for the extension of nut culture in the United States, especially for the walnut, chestnut, filbert and hickory nut. When people realize the great nutritive and hygienic value of nuts and learn to combine them properly with less concentrated foods, they will find their place as a part of our regular diet, and not serve merely as an ornament of the table during the holiday season. With our varied climatic and soil conditions in the United States we should certainly provide not only for our present needs, but also take care of the increase of population.

Between 1900 and 1910 the American production of nuts increased two and a half times as quickly as the population, yet in addition to this larger home production there was a large increase in nut imports. In 1910 the imports amounted to over sixty million pounds, valued at over twelve million dollars, while in 1920 the nut imports rose to over fifty million dollars, although the yield of American nuts increased largely since 1910. Compared with the enormous amount the American people pay annually for meat—nearly three billion dollars—the sum paid for nuts seems very small. For every dollar that goes to the purchase of meat, only

two cents are spent for nuts. The time will surely come when these figures will be reversed, much to the benefit of the health and longevity of man.

In the following pages the different varieties of nuts, their origin, cultivation and nutritive value will be fully described.

THE ACORN

The acorn *(quercus)*, the fruit of various species of the oak tree, has been used as food for a long time by the Indians of the Pacific Coast, from Puget Sound down to old Mexico. They had a process of removing the excess tannin, similar to that used in treating olives. The bitterness can also be removed by a slight process of fermentation, for which purpose the acorns are ground into a powder, and mixed with water or milk. This method sacrifices less of the nutritive value than that of leaching.

While the acorn has less protein than cereals, it has a larger per cent of fat, and acorn meal is, therefore, often used in combination with corn meal or wheat flour.

In the August, 1918, issue of the *National Geographic Magazine*, Mr. C. Hart Merriam, ex-chief of the U. S. Biological Survey, says that one part acorn to four parts corn, or wheat, makes palatable bread and muffins, adding the fat of the acorns to the cereals. John Muir, "the poet of the Sierras," during his arduous tramps in the mountains of California, often carried the hard dry acorn bread of the Indians, and considered it a most compact and strength producing food.

On some parts of the Mediterranean coast occasional species of the oak tree produce acorns as edible and nutritious as chestnuts. Such oak trees are often grown in grafted orchards, especially on the Spanish island of Majorca and adjacent portions of the mainland, where as large a proportion as twenty per cent of the food of the poor people consists of sweet acorns. A coffee substitute is also made from the roasted and ground acorns.

Although the acorn may not become popular as a food product in the United States, at least in the immediate future, the fact remains that the oak tree is one of the heaviest producers of a fruit rich in starch and fat.

An analysis of the unbleached acorn meal shows:

Water	8.70 per cent
Protein	5.70 " "
Fat	10.60 " "
Carbohydrates	65.00 " "
Fiber	6.63 " "
Mineral matter	2.00 " "

The mineral matter consists mostly of phosphate of potash, magnesia and an appreciable amount of iron.

According to Dr. Merriam, there are in the United States more than 50 species of oaks, of which 30 grow in the Eastern States, and about 15 in the State of California. To the native Indians of the Golden State, the acorn is, and always has been, the staff of life, furnishing the material for their daily mush and breads, and when it is remembered that the Indian population of California at the time of the establishment of the missions numbered not less than 300,000, and that acorns were universally eaten, and in most cases were the principal article of diet, some idea may be had of the vast quantity and high food value of those annually consumed.

THE ALMOND

The almond *(prunus communis)* is supposed to be native of Persia. It is cultivated throughout the countries bordering the Mediterranean Sea, which now supply the bulk of the world's demand. California is now the leading almond growing state of the United States, where the total acreage, bearing and non-bearing, is 100,000 acres.

The importation of both shelled and unshelled almonds from Europe in 1919-1920 amounted to over 33 million pounds, while the California production of the same years was about 10 million pounds. The average production of almonds is about 1,000 pounds per acre. Intensive, intelligent cultivation would doubtless increase the production after a few years to 1,500 pounds per acre. By 1925 California should be able to supply all the almonds consumed in this country.

The almond resembles the peach somewhat in manner of growth and character of blossoms and leaves, but the wood is much harder and the tree is longer lived under equally favorable conditions. The fruit, instead of having a thick fleshy pericarp, or hull, as in

the case of the peach, has a thin, leathery pericarp, which splits on ripening, and generally opens when dry, exposing the nut in the shell. The principal varieties grown in California are:

The California Papershell, a light bearing variety in most locations. This defect is partially offset by the fact that the waste in shelling the nuts is only about 30 per cent. The nut has a good flavor and is moderately sweet.

The Drake was originated by H. C. Drake, Suisun, California, on his home place, forty years ago. The tree is a heavy producer. The nuts are of medium size and have a thick, but soft shell. The pits are rather small, but numerous, two small kernels often being found in one shell.

The I. X. L. Almond, originated by A. T. Hatch, of Suisun, California, is one of the best for marketing in the shell because of its attractive appearance and uniform size and shape. It is a soft shell variety, light colored, which has a tendency to break open at the pointed end. The kernels are large, ovate, very broad and flattened, and of fair quality.

The Languedoc, one of the oldest varieties propagated in California, is now largely displaced by other varieties. The shell is hard and the kernels angular, plump, smooth, or slightly wrinkled.

The Ne Plus Ultra, another variety originated by A. T. Hatch, is chiefly valuable because of its attractive outside appearance and general large size. The shell is thick, corky or crumbly, sometimes very ragged. The kernel is reddish brown, oblong, flattened, somewhat wrinkled, and has a mild sweet flavor.

The Nonpareil, the most valuable of the commercially grown varieties of California, is the best known of the three "Hatch varieties." It is chiefly valuable because of its excellence for shelling purposes, and its uniform bearing qualities from year to year, while it is comparatively hardy and resistant to unfavorable conditions. It has a so-called paper shell, containing an oval, broad, flattened kernel of large size, of an oily, sweet flavor and excellent quality.

The Jordan, a European variety, grown in Spain, is imported to the United States in large quantities. This variety cannot be recommended for commercial growth in California, because of the great difficulty in shelling, which has to be done mostly by hand, and in which we are unable to compete with European labor. An-

other objection is the early blooming habit of the tree and its susceptibility to frost. The shell is hard, thick and bony; the kernel is large, completely filling the shell cavity. The flavor is rich, oily, and sweet, and the meat of very excellent quality, all of which makes it one of the highest priced nuts on the market. At present the Jordan can be recommended only for home orchards.

The Bitter Almond, which is chiefly grown in Morocco, Sicily and Southern France, is not very injurious when fresh, but it has a disagreeable taste, and this, in addition to the fact that one of the products of its decomposition is hydrocyanic or prussic acid, renders it undesirable. The bitter almond is used in large quantities in the manufacture of "bitter almond oil." Much of the prussic acid is removed in the process of cooking, and small quantities of this oil may be used for flavoring.

There are about fifty more varieties cultivated throughout the southern part of the United States, but at present California supplies by far the largest percentage of the home grown almonds, since its soil and climatic conditions are best adapted to commercial production. The sweet almond from a dietetic and hygienic point of view, is one of the best nuts. It contains no starch. The fat is composed of olein, with some palmitin and stearin. The average protein content is about 20 per cent; fat content, 50 to 55 per cent.

The carbohydrates are made up of about 6 per cent sugar, 3 per cent gum, and from 6 to 8 per cent of fiber and cellulose. The mineral matter is rich in phosphate of potash, lime, magnesia, and iron, but deficient in sodium and chlorine.

The composition of the almond is given in the following tables, in figures of per cent:

	European	California	Blanched
Water	4.42	6.90	4.00
Protein	17.28	24.00	17.68
Fat	54.30	54.00	54.75
Carbohydrates	18.64	10.00	19.19
Cellulose	2.58	3.00	1.60
Mineral matter	2.78	3.00	2.70

Almonds in the form of almond cream (almond butter diluted with water) make an excellent dressing for vegetables and fruit salads, and provide a most wholesome, delicious, and well-balanced combination, easily digested and assimilated. Almond milk, made

from almond cream by adding water and a little honey, may occasionally be given to infants and invalids.

To improve their appearance and increase their commercial value, almonds are frequently sulphured. They are spread out on wooden trays and put into air tight compartments, which are connected by pipes with a boiler. Steam is first turned on for a period of twenty minutes. This opens the pores of the shells, making them more susceptible to the bleaching effect of the sulphur. Then about one pound of sulphur is placed below each set of trays and ignited. For another twenty minutes the almonds are treated by sulphur fumes which combine with the moisture of the almonds into sulphurous acid. As in the case of sulphured fruits, this process is mainly employed to please the eye of the American public, at the cost of the hygienic value of the product.

THE BEECHNUT

The beechnut *(fagus ferruginea)* belongs to the oak family. The genus comprises about fifteen species of handsome deciduous and evergreen trees, or shrubs, very widely distributed throughout the temperate and colder regions of the Northern and Southern Hemispheres, but the nut has never been a commercial article in the United States. The beechnut is a small triangular kernel, which resembles the chestnut in shape. It contains about 20 per cent protein, 50 per cent fat and 20 per cent carbohydrates, mostly in the form of starch and cellulose; and 3.7 per cent mineral matter, consisting of a large amount of lime, magnesia, iron, and more sodium and chlorine than any of the other nuts. Like the chestnuts the beechnuts are rendered more digestible if slightly roasted or boiled.

THE CASTANOPSIS

The Castanopsis *(castanea sempervirens)*, also called *golden chinkapin* and *California Chestnut,* is a genus of evergreen trees, intermediate between the oak and the chestnut. This handsome broad-leaved tree is indigenous to the elevated regions, from Monterey, California, northward to the Columbia River in Oregon. It is also common in the Sierra Nevadas at elevations of six thousand feet, but in its southern limits rarely below ten thousand feet elevation. In the warmer and drier regions of California it is a

mere shrub two to six feet high, and these dwarf forms have, in some instances, been described as varieties.

The small, conical nut is slightly triangular, with a rather firm, brittle shell, not fibrous as with the acorn and chestnut. The burrs are usually produced singly but sometimes there are several on a twig, and when mature, instead of opening by valves, as in the true chestnut, they break up irregularly. The kernels are sweet and of excellent flavor, and are sought after by birds and squirrels. The castanopsis remains during winter in a partly developed stage, usually ripening the second year in midsummer.

THE CHESTNUT

The European chestnut *(castanea sativa)* is supposed to be indigenous to Asia Minor, Caucasus and northern Africa, and from these countries it was introduced and became naturalized throughout the greater portion of temperate Europe, where it has been cultivated from time immemorial. The Romans are supposed to have distributed it northward through France and Great Britain, and in the latter country there were trees centuries ago of so large size that many of the English authors claimed they were indigenous. All the early Roman writers who deal with rural affairs, mention the chestnut as one of their valuable trees.

At present the cultivation of the chestnut consists largely in grafting good varieties upon trees that produce inferior fruit, for which purpose the single kernel variety is preferred to the wild species, which contains two or three kernels. The chestnut is not yet produced in large quantities, and a certain amount is annually imported from Italy and Spain. There are but few chestnuts grown in California.

In the south of France and in Corsica a large portion of the population during the winter live chiefly on chestnuts and foods made from chestnut flour, and show remarkable health and vigor. There is probably no other country where chestnut trees are more plentiful than on the island of Corsica. The amount of wealth represented by these trees in that comparatively poor island is shown by the fact that a few years ago chestnuts aggregating in value one million dollars were exported from there.

The chestnut is also an important crop in Italy, where the yield in 1916 was 696,244 tons, and forms one of the chief food stuffs

of the working class. Chestnuts also figure largely in the food resources of the farming population of Spain, Switzerland and Germany. They are eaten raw or roasted, or ground into flour. The Corsican mountaineer eats his chestnuts fresh, boiled, roasted, made into mush, baked on the griddle, or in a loaf. They take the place, to a large extent, of cereals.

The tree is prolific; it is claimed that the average annual yield of good mature chestnut orchard land is from two to three thousand pounds per acre.

Aside from its desirability as an orchard tree, the chestnut may be commended as suitable for hillsides, or as a shade tree for highways, and should be more widely planted in the western portion of the United States where the climatic conditions are favorable. Trees that were planted in the Sierra Nevada foot hills about twenty years ago and are now fifteen inches in diameter at the base of the trunk and forty feet high, are reported to bear a barrel of nuts per tree regularly.

An analysis of the dried chestnut shows on an average:

Water	6.0 per cent
Fat	8.0 " "
Protein	10.0 " "
Water ? or carbohydrates ?	70.0 " "
Cellulose	3.0 " "
Mineral matter	2.4 " "

This proves that chestnuts surpass the best of cereals in nutritive value, also in the yield per acre. Moreover, the trees can be grown on the hillsides, where the cultivation of cereals would be unprofitable.

The chestnut differs widely from the other common nuts, as it contains much less oil and protein, and much more of the carbohydrates, especially starch, which is almost entirely wanting in many nuts. The mineral matter of the chestnut consists largely of phosphate of potash, magnesia, with an appreciable amount of sodium and iron.

Mention has already been made of chestnut flour which is for sale in many of the Italian grocery stores of the United States, and is largely used for culinary purposes. In some parts of Italy it is used extensively for making bread and cake.

The whole nuts are eaten in a variety of ways, boiled in water

without hulling; hulled and boiled, or roasted. The first method is undoubtedly the best, as it preserves the organic salts. Sometimes dough made from chestnut flour and water is spread between chestnut leaves and baked in an oven or between hot stones.

Extensive experiments have been made in regard to the digestibility of cooked chestnuts, showing a high digestion coefficient; but the raw chestnut starch, which is found to be comparatively indigestible, suggests the desirability of boiling or roasting the nut in its hull, thus rendering it more palatable. Boiled chestnuts with green leaf vegetables constitute a nourishing and satisfying meal, and, in many ways, take the place of cereals.

Several other species of the chestnut may be briefly mentioned here:

The AMERICAN CHESTNUT *(castanea dentata)* is a very large and common tree in the middle and northern states, living to a great age. The leaves are oblong, lanceolate, with rather coarse teeth, each terminating with a feeble prickle or spine, smooth on both sides. The burrs are thickly covered with sharp, branching spines a half inch long or less, opening by four valves or divisions when mature. There are usually three nuts in each burr, containing sweet and fine grained kernels.

THE CHINKAPIN CHESTNUT *(castanea pumila)* is a medium-sized tree twenty to forty feet high, growing in rich soils in New Jersey, Southern Pennsylvania and southward to Georgia and sparingly westward to Arkansas. The leaves are similar in shape to those of the American chestnut but they are green above and covered with a fine hair beneath. The burrs which are generally two-valved, grow in clusters. The nuts are solitary, ovid, pointed, with a dark brown, polished shell. The kernels are fine grained, sweet and of excellent flavor. The chinkapin is resistant to blight, and some of the hybrids retain this resistant quality while bearing nuts of good size and high quality.

The JAPANESE CHESTNUT *(castanea japonica)* is a tree of moderate height, rarely exceeding fifty feet in Japan. The growth is slender in comparison to the European or American chestnut, and the habit is decidedly bushy, the new growth of the season usually producing a number of lateral twigs late in summer. The nuts are large, usually three in a burr. The shell is thin, and of a light brown color. The inner skin is thin, fibrous, but not as bitter as in

European varieties, while the kernel is somewhat finer grained and sweeter.

The WATER CHESTNUT, or horn chestnut *(trapa bispinosa)* may also be mentioned here. The tubers, or corms, of this plant are widely used in China and Japan, and they are also for sale at Chinese shops in the United States. They usually grow wild in moist places and are not cultivated. They are sweet and juicy when fresh, and resemble the chestnut in size and flavor, having a brown skin and white interior. The carbohydrates are made up of equal parts of starch and sugar, which give them a sweet taste and make them valuable as a raw food. The composition of the fresh water chestnut is as follows:

Water	77.30 per cent
Fat	0.15 " "
Protein	1.53 " "
Sugar	8.40 " "
Starch	7.34 " "
Fibre	0.94 " "
Mineral matter	1.20 " "

The WATER CHINQUAPIN *(nelumbium luteum)*, frequently called "water chestnut," is the seed of the large yellow water lily, a very common plant in small ponds in the southern and eastern part of the United States. The seeds are about the size and shape of small acorns and are produced in a large top-shaped, fleshy receptacle. They are edible, and are supposed to have been extensively used as food by the Indians. Another variety is the *nelumbo nucifera* with rose colored flowers, the Egyptian bean of Pythagoras, or the lotus held sacred by the Hindus. It has been used as a food by the Egyptians from remote antiquity, and is much esteemed where it is cultivated, especially in China, for its edible seeds, roots, leaf-stalks and flower-stalks. The seeds resemble large acorns in size and shape and are said to have a more delicate flavor than almonds. The root contains much starch and Chinese arrowroot is said to be obtained from it.

THE HAZELNUT

The hazelnut, or filbert *(corylus)* is found wild in most European countries, and is cultivated in all temperate regions of the earth, especially in Asiatic countries, bordering on the Black Sea. In the United States the native hazel bushes produce a considerable

quantity of hazel nuts, but a larger variety of the same species, known as the filbert, is imported from Spain and from the port of Trebizond, on the southeastern shore of the Black Sea. Another variety, known as the cob-nut, which is broader and shorter than the filbert, but not so fine in quality, is grown in Kent and Sussex, England.

On the Pacific Coast, the most favorable sections for the cultivation of the filbert are the slopes of the Coast ranges, from Santa Cruz northward as far as the Canadian border, where sufficient moisture is assured without irrigation.

The edible portion of the dried filbert has the following average composition:

Water	5.0	per	cent
Protein	15.0	"	"
Fat	64.0	"	"
Carbohydrates	13.0	"	"
Mineral matter	2.4	"	"

The latter is especially rich in lime, magnesia, and iron.

THE PISTACHIO

The pistachio *(pistacio vera)* a native of Syria, has long been cultivated in the Mediterranean countries, whence comes the bulk of these nuts used in the United States. The pistachio was introduced into the Southern States during the middle of the last century, but thus far has not been grown extensively. Small quantities of this nut have been grown successfully in the warm interior valleys of California.

The fruiting of the pistachio depends upon pollination, and one male tree is necessary to six or seven bearing trees.

The kernel, which has the shape of a small almond, is greenish in color and has a mild, individual flavor, not altogether unlike that of almonds. In the United States it finds its largest use in the manufacture of confectionery, for which purpose it is valued for flavor and color. The composition of the nut is as follows:

Water	4.2	per	cent
Protein	22.6	"	"
Fat	54.5	"	"
Carbohydrates	15.6	"	"
Mineral matter	3.1	"	"

THE HICKORY NUT

The hickory nut *(carya)* is one of the finest wild nuts of the United States. The early white settlers of the Atlantic States found the nuts in common use among the Indians, who gathered and stored them in large quantities in the fall for food during the winter months. It is a deplorable fact that those settlers lacked appreciation for such choice gifts of nature, and in their desire to secure land for the cultivation of cereals, ruthlessly destroyed the splendid forests, without thinking of preserving trees that would furnish food for themselves and succeeding generations. Indeed, as hickories yield superior timber for various agricultural and other implements, as well as for fuel, they were often utilized in advance of the general clearing of woodlands. It is to be greatly deprecated that with the many millions of dollars expended by the U. S. government to encourage the planting, preservation and cultivation of forest trees, no special appropriation has been made for the nut bearing trees, which are really the great food producers of nature.

Professor C. S. Sargent, a well known horticulturist, describes sixteen species of hickory nuts, and, in addition, a large number of varieties due to environment and others due to hybridization. Another species of hickory has been found in Mexico making seventeen species for the North American Continent. Of the two botanical names suggested for the hickory, "*hickoria*" and "*carya*" the latter has been finally adopted. The name "Hickory," therefore, is collective and generally applies to different species found in the different parts of the United States. In the northeast it applies to the shagbark *(carya ovata)*, in Missouri it means the "shell bark" *(carya laciniosa)*. Then there are a number of hickories which have nuts with a bitter skin, such as the bitternut *(carya cordiformis)*, bitter pecan hickory *(c. texana)* and water hickory *(c. aquatica)*. The name "pignuts" is generally applied to two species *(c. glabra* and *c. ovalis)*. The species which has come into great prominence lately is the pecan *(carya pecan)* which will be described under a separate heading.

The shagbark hickory derives its name from the peculiar shape of rough, shaggy bark which peels off in strips as the tree advances in age. The nuts of this tree were highly esteemed by the Indians. William Bartram, in the account of his travels through the South-

ern Atlantic States, from 1773 to 1778, published in Philadelphia in 1791, says, in referring to these nuts:

"They are held in great estimation by the present generation of Indians. I have seen above a hundred bushels of these nuts belonging to one family. They pound them to pieces, and then cast them into boiling water, which, after passing through fine strainers, preserves the most oily part of the liquid, this they call by a name which signifies hickory milk. It is as sweet and rich as fresh cream, and is an ingredient in most of their cookery, especially in hominy and corn cakes."

The shagbark hickory has a natural range from the Atlantic coast to the Mississippi River, although it is at its best north of Tennessee and the Carolinas.

The shell bark hickory produces large nuts with a kernel equal to that of the shagbark in quality. Since the nuts have, as a rule, a very thick shell, the extraction of the meats offers some difficulties. There has been but little accomplished in the improvement of the shell bark or in perpetuating the superior varieties discovered, on account of their great variation when grown from seed, and the difficulty of propagating them by budding and grafting.

The meat of the shell bark hickory is largely used by confectioners and a large trade is done in the kernels, an important feature of the nuts being their "cracking quality." In this respect, the kernels are equal, if not superior, to those of the Persian walnut.

One of the soft shell varieties of the shell bark hickory is known as *Hale's Paper Shell.* It originated on the farm of Mr. Henry Hale, of Ridgewood, New Jersey, and the first tree is now over one hundred years old. It is about seventy-five feet high and nearly two feet in diameter. The nuts are very large, while the shell is very thin, in fact, much thinner than many pecans that come to the northern markets. The kernels are full, plump, rich, and delicious, with the rare feature of retaining their excellent quality for two or more years without becoming rancid. So far but few varieties of shell bark hickory have been dignified with a name. Probably the first to be named was Hale's Paper Shell.

The edible portion of the hickory contains on an average:

Water	3.7 per cent	Carbohydrates	11.4 per cent
Protein	15.4 " "	Mineral matter	2.1 " "
Fat	67.4 " "		

THE PECAN

The pecan *(carya pecan)* belongs to the species of hickory nuts and is a native of America, being found from Indiana to Iowa in the North, and from Tennessee to Texas in the South. It thrives best in the rich, moist soils along the river banks. It is the hardiest of all nut trees, being free from all ordinary tree pests and diseases because it is of the hickory group. The lack of surface moisture, the great enemy of most trees, is not a disadvantage to the pecan, for it has a remarkably long tap root, which goes down so deeply into the ground that it draws moisture from the sub-soil. Since the blooming is late in the spring, the buds are not injured by frost.

There are three different classes of pecans: the ordinary wild pecan, the seedling pecan, and the paper shell pecan, now being cultivated extensively in Georgia by Elam G. Hess, Manheim, Pennsylvania, to whom I am indebted for some of the following data.

The ordinary wild pecan is a native to America. The earliest French explorers found that one of the staple foods of the Indians was this palatable nut, which grew in the forests of the South and in northeastern Mexico. Pecan trees in the Gulf States have been found which were over five hundred and seven hundred years old, still yielding large crops of nuts. There are in the Southern States wild pecan trees of which the records go back to the earliest civilization of this continent.

The seedling pecan is the next step toward pecan perfection. Larger than the wild pecan, and thinner shelled, it equals or surpasses it in flavor, depending upon the variety of seedling under consideration. Selling at an average price of 35 to 45 cents per pound, which is double the cost of the wild pecan, it has so much more meat and it is so much more accessible that it is always a better paying purchase and will gradually supplant the thick shelled, wild pecan, which is generally brightly tinted and polished to disguise its inferiority.

The paper shell pecan was developed from budded trees. It has an air-tight shell so thin that it is easily broken in one hand by gentle pressure. Its kernel is large, easily removed, its flavor so much finer that anyone can immediately distinguish it from other pecans by taste alone.

Instead of a bitter partition wall which imbeds itself in the nut

when it is cracked, as in the wild pecan, the paper shell pecan has a thin, tissue-like membrane which is easily removed. In fact, in the paper shell pecan a larger portion of the total weight of the nut is meat than in any other nut, with the possible exception of the finest almond.

The only disadvantage of the paper shell pecan is the limited supply, for there is but a small territory in which climatic and soil conditions are right. While the walnut is raised in countries throughout the temperate zones, the paper shell pecan seems to flourish best within a forty mile radius around Albany, in southwest Georgia, about one hundred miles south of Atlanta. Of the half million budded trees in the world, two hundred forty thousand, or practically half, are in this forty mile radius. The pecan in this belt is one of the most dependable crops in this country, and will doubtless produce profitable crops for centuries to come. A fifteen-year-old pecan orchard will yield about 2,500 pounds of nuts per acre, worth at least $1,000, or $50 per tree. Some growers report from 465 pounds to over 600 pounds of pecans from trees over twenty years old.

The pecan tree is a great producer of concentrated food and one of the most profitable and permanent investments.

While the protein content of the pecan is less than that of other nuts, it has the highest percentage of fat of all nuts. The composition of the edible portion is as follows:

Water	3.4 per cent
Protein	12.1 " "
Fat	70.7 " "
Starch and Sugar	8.5 " "
Cellulose	3.7 " "
Mineral matter	1.6 " "

One pound of pecans has more than three times as much nutritive value as the average cuts of meat. One full grown pecan tree can easily keep an adult man constantly supplied with more protein and fat than he needs.

At present Texas is the leading pecan producing state, with over one million trees, mostly wild pecans. Georgia with 450,000 trees comes next, followed by Oklahoma with over 400,000 trees. The total amount of pecan trees in all the Southern States is over 2,500,000 trees, producing more than thirty million pounds annually.

THE PINE NUT

The name "pine" *(pinus)* is applied to many different species of pine trees, growing in both hemispheres. In southern Europe, especially in Italy and southern France, the seeds of the stone-pine *(pinus pinea)* have been extensively used as food from the earliest times. Many ancient writers refer to them as among the most valuable products of the country. The pine nuts are called *pinocchi* in Italy and Sicily, from which they are exported shelled, in considerable quantities into the United States under the name of *pignolias.* These nuts have a very soft texture and agreeable flavor, but have a slight taste of turpentine, which can be removed by heating the nuts for a short time, without roasting them.

In this country we have several species, bearing large, edible seeds, known under the general name of *piñons* or *pines.* They grow especially in the states of Colorado, New Mexico, Arizona, and Mexico, and are usually gathered by the Indians for commercial purposes. They are sold in a large number of fruit stores on the Pacific Coast. The pine-nut has a rich, marrowy kernel in a shell that varies in thickness from that of a chestnut to that of a hard shell hazel nut.

The imported pignolias have the highest percentage of protein of any natural food, and while the protein content of the native pine-nut is lower, its fat content is higher than that of the imported nuts.

The following table gives the chemical composition of the pignolias, piñons and sabin pine-nuts:

Analysis of the Edible Portion in Per Cent:

	Pignolias (Imported)	Pinons	Sabin Pine Nuts
Water	6.4 per cent	3.4 per cent	5.1 per cent
Protein	33.9 " "	14.6 " "	28.1 " "
Fat	49.4 " "	61.9 " "	53.7 " "
Carbohydrates	6.9 " "	17.3 " "	8.4 " "
Mineral Matter	3.4 " "	2.8 " "	4.7 " "

The pine nuts contain a larger amount of lime than any of the other nuts. They also contain an appreciable quantity of magnesia and iron.

The Sabin pine *(pinus sabina),* a European species, seems

quite at home in the northeastern part of the United States, and so does the Swiss pine *(pinus cembra)*. The Italian stone pine *(pinus pinea)* favors a little warmer climate, especially hillsides with southern exposure, and also needs some degree of wind break protection. There are about thirty different species of conifers of the nut-bearing group which are to be tried out more extensively between the Canadian border and Florida. Nut bearing conifers, for the most part, belong to the warmer parts of the temperate zones. They grow slowly when transplanted north of 40 degrees latitude. The country west of the Rocky Mountains, with its milder climate, seems to be especially adapted for their growth. The sugar pine *(pinus Lambertiana)*, for example, one of the most magnificent forest trees of the Sierra Nevada Mountains, has rich sugary and oily nuts, furnishing also a solid sugar from its evaporated sap. The common pinon *(pinus edulis)* is the one principal forest tree in Arizona, New Mexico, and northern Mexico.

THE WALNUT

The walnut comprises about eight species, and three or four of these are indigenous to the United States. The Latin name *juglans,* first used by Pliny, is an abbreviation of *Jovis glans*, the nut of Jove or Jupiter.

The best known species is the Persian walnut *(juglans regia)*, commonly called English walnut, although it was brought here from Spain and France by missionaries, and most of the European imports come from France and Italy. The different varieties of this nut are now believed to have descended from trees native to the southern shores of the Caspian Sea and northern Persia. It was introduced into the Mediterranean countries early in the Christian era, and later into northern France, southern Germany and England.

The wild form of this famous nut is doubtless quite different from the varieties with which we are familiar. Two thousand years of continuous cultivation and selection have greatly changed the character of these nuts, as well as their habits. The nuts from the wild trees are said to have a rather thick shell, and to be much smaller than the improved cultivated varieties. While some old productive English walnut trees are found throughout the Eastern and Middle States, this variety seems to have succeeded better

in California, especially in Southern California and the coast countries, where large commercial orchards have now been planted. Oregon is following California rapidly as a nut growing state.

The California black walnut *(juglans Californica)* is now chiefly used as a resistant stock for the English walnut, and either grafting or budding is resorted to. The best known varieties of English walnut are the Santa Barbara, Soft Shell, Placentia, Perfection, (sold as budded walnuts), Eureka and the Franquette, the last a very large elongated oval nut with rather thick shell, but containing meat of high quality.

Unfortunately, the general market in the United States seems to call for bleached walnuts, which are more attractive to the eye. Sulphuring, however, depreciates the aroma of the nut and leaves the kernel with a lowered quality. Most of the California growers are using now harmless cleansing materials and for that reason will hold the discriminating trade. It is certain that English walnuts of highest quality sent to the Eastern market unbleached, will eventually command a higher price than sulphured nuts.

Walnut orchards in full bearing should produce from 1,000 to 1,200 pounds of nuts per acre, while extraordinary yields are as high as 2,000 pounds. The California Walnut Growers' Association announced for 1922 a walnut crop estimated at 48 million pounds, valued at $15,000,000. In addition, 50 million pounds were imported into the United States during the nine months preceding this report.

The black walnut *(juglans nigra)* grows wild over a large portion of the American continent, especially along the Ohio and Mississippi Valley. The nut has a thick, hard shell, but contains a well-flavored meat.

The butternut *(juglans cinerea)*, sometimes called "white walnut," which grows abundantly in the United States and Canada, also belongs to the walnut family. The fruit is oblong, two or more inches in length, with a clammy husk, not opening when ripe, but closely adhering to the deeply corrugated thick shell. It is also a valuable timber tree, with soft white wood, much used for furniture.

The chemical analysis of the edible portion of the three following varieties is:

	English Walnut	Black Walnut	Butternut
Water	2.5 per cent	2.5 per cent	4.5 per cent
Protein	18.4 " "	27.6 " "	27.9 " "
Fat	64.4 " "	56.3 " "	61.2 " "
Carbohydrate	13.0 " "	11.7 " "	3.4 " "
Cellulose	1.4 " "	1.7 " "	
Mineral matter	1.7 " "	1.9 " "	3.0 " "

The English walnut is rich in lime, magnesia and iron salts, but like all nuts, is deficient in sodium and chlorine. The walnut is more difficult to blanch than the almond, hence not so well adapted for making nut butter. Finely grated and sprinkled over vegetables and fruit salads, it makes an ideal combination, taking the place of salad oil.

The Chinese walnut *(juglans sinensis)* is also a common variety of the Persian walnut. It is very hardy and in China grows in much colder regions than those in which Persian walnuts of European origin will thrive. Nuts of the Chinese tree have a rather thick shell and the kernel is rich, but not well flavored. This variety would be best for the North Atlantic States where the climate conditions are similar to those of the northeastern Orient. Chinese walnuts have been imported in fairly large quantities by the Pacific Coast States.

The Japanese walnut *(juglans cordiformis)* comes from the Island of Pezo, the most northern portion of the Japanese Empire. This nut should grow successfully throughout the United States, as it has withstood a cold of several degrees below zero at Parry, N. J., without the slightest injury. The nut is of peculiar heart-shape, hence its botanical name. The kernel is full and plump, equalling in flavor the Persian walnut, while its cracking qualities are superior to any other known varieties, for by boiling the nuts for five minutes and cracking them by a slight tap while still hot, the thin shells readily part and the kernels can be extracted whole.

When the tree is in blossom with catkins of male flowers five or six inches in length and bright red spikes of female flowers glowing amidst the foliage we have a very attractive object, worthy of attention for beauty alone. The Japanese walnut, even as a seedling tree, may begin to bear when only five or six years of age.

THE PEANUT

Although in a strictly botanical sense the peanut *(arachis hypogoea)* is not a nut, but a legume, it is here included among the nuts, whose chemical composition it closely resembles. Since the close of the Civil War the peanut has come gradually into prominence in the United States until over two million acres are now devoted to its cultivation, yielding an average of thirty to forty bushels per acre.

The peanut, probably a native of Brazil, was introduced soon after the discovery of that country into Africa and other tropical portions of the Eastern Hemisphere, where it has become a staple food. In the United States the climate of the Atlantic seaboard and the Mississippi Valley has proved most congenial to this plant, which needs an early and warm spring, followed by a hot and moist summer, with but little rain in the harvesting season, for rain injures the mature crop.

The peanut, often called "earth nut" or "ground nut," derives these names from the peculiarity of the development of its pods. Its blossom is at the end of a long pedicel-like calyx tube, the ovary being at the base. After the fall of the flower the peduncle, or "spike" elongates and bends downward, pushing several inches into the ground, where the ovary at its extremity begins to enlarge, and develops into slightly curved pods, containing from one to three seeds.

In some of the Southern States, the annual yield of the peanut plant has been greatly reduced, chiefly owing to the continued annual planting of nuts on the same land, lack of proper rotation of crops, the removal of nearly all vegetation from the land, and failure to replenish the soil by means of proper fertilizers.

Like other leguminous plants the peanut is rich in nitrogen and contains considerable amounts of phosphoric acid and potash. The mineral matter in the dried vines amounts to over 15 per cent. These vines should be plowed under, and mineral fertilizers applied.

The principal varieties of peanuts grown in this country are the Virginia and the Spanish peanut. In Costa Rica there is a variety with long undivided pods, containing four or five seeds, while in the Argentine Republic a large size variety with a deep

orange colored shell is grown. Considerable quantities of peanuts are raised in India and West Africa, principally for the oil that is contained in the kernels.

The chemical analysis of the various kinds of peanuts grown in different districts naturally shows a wide divergence, especially in the amounts of protein and fat, the former ranging from 25 to 35 per cent, the latter from 41 to 55 per cent. The average composition of the peanut, as a result of over two thousand analyses is as follows:

Water	7.8 per cent	Starch and Cellulose	11.0 per cent
Protein	29.4 " "	Mineral matter	2.8 " "
Fat	49.0 " "		

Like all seeds, the mineral matter consists chiefly of phosphoric acid, and, according to Koenig's analyses, the peanut has the largest amount of iron of all the nuts analyzed, while it is deficient in sodium and chlorine. It should, therefore, be eaten with discrimination, as it is a highly acid-forming food.

While in Europe the peanut is mostly used in the production of edible oil, in the United States it is consumed in various ways, roasted and salted, in peanut candies, peanut butter, and to a lesser extent, the seed is used for its oil. About 26,000,000 pounds of peanut oil were produced in 1916. The U. S. Department of Agriculture has recently recommended the use of peanut meal, mixed with corn meal and wheat flour, for biscuits, muffins, cakes, puddings and soups. The ordinary peanut butter, made from heavily roasted peanuts and salted, is not wholesome. An excellent butter can be made from blanched nuts, but slightly heated to remove the earthy flavor and surplus of moisture. If diluted and mixed with water to the consistency of cream, the butter makes an excellent salad dressing.

During the past ten years peanut oil has come into competition with cotton-seed oil, but there are some fundamental differences between these two oils. The proportion of hull to meat is less in the peanut than in cotton-seed, and as the shell of the peanut is more absorbent than cotton-seed hulls, the loss of oil in pressing unshelled peanuts is greater than with cotton seed. On the other hand, shelling can be accomplished much more readily with the peanut than with cotton-seed. The really important difference between these two seeds, however, is in the oil itself. Cotton-seed

oil belongs to that class of vegetable glycerids which have to be refined before they are edible, whereas peanut oil, if properly pressed from sound stock, has a good color, a sweet, nutty flavor, and is a thoroughly satisfactory table oil just as it runs from the press. Naturally, there is more or less insoluble matter—fine particles of the nut—which have to be removed in order to prevent a rapid deterioration of the oil, but this is easily done by filtering. In this respect, peanut oil is like olive oil, the best grade of which appears on the table just as it comes from the fruit, in fact, just as it existed in the olives themselves. In former years a good deal of the imported olive oil was adulterated with peanut oil.

Those who have tried prime, cold pressed peanut oil, consider it equal to olive oil, but the flavors are quite dissimilar. Refined peanut oils, however, are not superior to cotton-seed or corn oils, from a hygenic point of view. At present the United States is importing about 1,500,000 gallons of peanut oil, annually.

A bushel of good Spanish peanuts will yield from one and one eighth to one and one-quarter gallons of oil, and any fairly successful farmer can produce from 40 to 60 bushels per acre. Yields of 75 to 100 bushels are not uncommon.

China is probably the leading peanut growing country of the world, with an annual production of 365,000 tons, about twice as large as that of the United States.

THE CHUFA

The Chufa, earth almond or earth chestnut *(cyperus rotundus)*, is a perennial plant that spreads extensively by its under-ground root stocks. It bears numerous small edible tubers about the size of peanuts. Like the latter, the chufa belongs to the vegetable family but as its chemical composition also resembles that of nuts, it may be mentioned here. The tubers, when dehydrated or slightly parched have a fine flavor. Chufas grow well upon light sandy soils and produce large crops, but, so far, they have not been largely cultivated. A very delicious oil is manufactured from the dried chufa.

The chemical analysis of the chufa is as follows:

Water	2.2 per cent	Carbohydrates	50.2 per cent
Protein	3.5 " "	Crude fiber	10.5 " "
Fat	31.6 " "	Mineral matter	2.0 " "

Tropical Nuts

THE BRAZIL NUT

The Brazil nut, or guvia *(Bertholletia excelsa)*, is grown chiefly in Brazil and surrounding countries. It is one of the most remarkable fruits of South America, and was first made familiar to us principally through the descriptions of Alexander von Humboldt. The fruit consists of a globular formation as large as an infant's head, and when ripe the seeds fall out. These seeds are nuts about one and one-half inches long and triangular. The meats are mild, yellowish white, and have a fine creamy flavor. They contain but little starch and sugar. The importation of these nuts into the United States amounts annually to about one thousand tons.

The tree that produces the Brazil nut is only two or three feet in diameter, but reaches a height of 120 feet. It is one of the wonders of vegetable life in the tropics. In fifty or sixty days a shell is formed, half an inch in thickness, which is rather difficult to open. The grains which this shell contain have two distinct envelopes. Four or five, and sometimes as many as eight, of these grains are attached to a central membrane. The weight of the entire fruit is so heavy that at the period when it falls the savages dare not enter the forests without covering head and shoulders with a strong protection made from wood. The gathering of the nuts is always an occasion of great celebration among the natives, so highly do they appreciate their value. They are very rich in lime and magnesia. The Brazil nut contains:

Water	4.7	per cent
Protein	17.4	" "
Fat	65.0	" "
Carbohydrates	5.7	" "
Cellulose	3.9	" "
Mineral matter	3.3	" "

THE CANDLE NUT

The candle nut *(aleurites triloba)* comes from a small evergreen tree, a native of Malay, southern Japan, and nearly all the tropical islands of the Pacific Ocean. In some instances the tree is mainly cultivated for the fruit, which is about two inches in diameter. In the center there is a hard nut, very oily, with the

flavor of the walnut. The oil obtained from these nuts is in common use among the natives of the South Sea Islands. In the Hawaiian group the kernels are strung on a small dry stick, which serves the purpose of a wick, and then one end is lighted, as with an ordinary tallow or wax candle, hence probably the common name of "candle nut." Large quantities of oil are also made from the nuts and used for various purposes.

The chemical analysis of the edible portion of the candle nut shows the following constituents:

Water	5.9	per cent
Protein	21.4	" "
Fat	61.7	" "
Sugar and starch	4.9	" "
Crude fiber	2.8	" "
Mineral matter	3.3	" "

THE CASHEW

The cashew *(anarcardium occidentale)* is a spreading, evergreen tropical tree, often attaining a height of forty feet. It is indigenous to tropical South America, whence it was carried to Asia, Africa, and the West Indies, where it grows in abundance. In the United States the culture of this tree is limited to the coast of Florida south of Palm Beach and Punta Gorda. Experiments to introduce the tree into California have not been successful.

The fruit is peculiar. The part that appears to be the fruit is in reality the swollen peduncle and disk, while the fruit proper is the kidney-shaped cashew nut, attached to its lower end. The fleshy part differs in size, being from two to three and one-half inches in length. The surface is commonly brittle and yellow, or flame-scarlet in color. The skin is very delicate, easily broken; the flesh, light yellow in color, and very juicy. The kidney-shaped nut, which is attached to the lower end of the fruit, contains the single oblong seed.

The cashew apple, as the fruit may be called, is soft, juicy, acid, and having before maturity a high degree of astringency, of which a sufficient quantity is retained in the ripe fruit to lend it zest. Owing to its remarkable penetrating, almost pungent, aroma, the jam or sweet meat made from the fruit possesses a characteristic and highly pleasing quality.

The cashew nut is kidney-shaped, and about an inch in length.

The soft, thick, cellular shell, incloses a slightly curved white kernel of fine texture and delicate flavor. The nuts should be roasted before being eaten. The shell contains cardol and anacardic acid, which burns the mouth and lips, if one attempts to bite into the fresh nut. Since these acids are decomposed by heat, the roasted nuts are more palatable.

THE COCOANUT

The cocoanut *(cocos nucifera)* is one of the most widely known and largest of edible nuts. It is indigenous to nearly all the tropical seashores.

There is perhaps no other food product that serves so many purposes as the cocoanut. An investigator has enumerated eighty-four distinct uses for the products derived from the cocoanut tree, the most important of which are identified with food stuffs.

Natives have always grown the tree primarily for their own use, rather than trading purposes, and it is only during the last fifty years that European and American capital has taken hold of the cocoanut industry on a large scale.

It is estimated that on an average a native consumes about sixty cocoanuts a month, these furnishing him both meat and drink that require neither cooking nor artificial preparation. In fact, he may be said to derive his entire livelihood from this remarkable tree, since it provides him with food, shelter, and even clothing. As a rule, the native figures his wealth by the number of cocoanut trees he possesses; and twenty of them in full bearing, occupying a space of less than half an acre, are considered sufficient to keep a man comfortable throughout the year.

Before the cocoanut shell becomes hard in the ripening process, the meat is found as a creamy substance, from which the milk has not yet separated. In this state the nut contents may be eaten with a spoon. If slightly sweetened with honey or fruit juice, they are palatable and refreshing. On the seacoast of Venezuela the people to a large extent live on cocoanuts and cassava, a starchy root which serves as a substitute for bread. In some parts of the West Indies the natives prepare a cocoanut butter by grating the meat and boiling it in water. The oil gradually rises to the surface and is

COCO PALMS IN SOUTHERN FLORIDA

skimmed off and allowed to stand for a few hours and then churned, making a quite palatable white fat, resembling cow's butter. Four nuts are generally required to make one pound of this fat. A good size cocoanut, with the husk, weighs about 5 pounds and contains about 1¼ pounds of meat and 1 pint of milk.

According to recent data, there are at least 3¼ million acres planted in cocoanuts in various parts of the tropics, the annual production aggregating about eight billion nuts. It is estimated that an acre of full grown cocoanut trees produces about fifty nuts per tree or 2400 nuts per year. On an average, three cocoanuts are required to make one pound of copra (dried cocoanut), or one pound of desiccated cocoanut. The latter is manufactured chiefly in the large cocoanut growing centers, like Ceylon and the Philippine Islands, while the copra is shipped to American and European ports for the manufacture of fat, which is often churned with some peanut oil and milk into a butter and given different trade names. These butters, sold as oleomargarines, more or less heavily salted and treated with preservatives, are practically devoid of mineral elements and vitamins, and cannot compare in nutritive and hygienic value to butter made from the desiccated cocoanut, which, in addition to fat, contains the tissue building elements.

Two analyses of desiccated cocoanut show an average:

Water	3.5	per cent
Protein	6.3	" "
Fat	57.4	" "
Carbohydrates, including fibre	31.5	" "
Mineral matter	1.3	" "

The latter contains a considerable quantity of potash and phosphoric acid, also small amounts of sodium, calcium, manganese and iron. In combination with fruits, the cocoanut in its various forms, if properly prepared, makes a well-balanced diet.

THE QUEENSLAND NUT

The Queensland nut *(macadamia ternifolia)* is an evergreen tree or tall shrub indigenous to eastern Australia. It has been cultivated successfully in Southern California. Aside from the value of its fruits, the tree is desirable for its ornamental value in gardens as well as on streets and avenues. For this purpose its

drought-resisting qualities make it particularly useful. Its dark green, serrated leaves greatly resemble those of the holly.

The nuts are abundantly produced in clusters of from three to fourteen, enclosed by a hull similar to that of the hickory nut. They are round, smooth, light brown in color and about an inch in diameter. The shell is thick, and encloses a round kernel, similar to the filbert, but larger. The flavor resembles that of the Brazil-nut, but is greatly superior to it.

The tree comes into bearing when seven or eight years of age, and thrives best on a heavy soil. It requires but little care and for that reason is desirable for door yard planting. Trees have been bearing in California for a number of years, and are as perfectly at home there as in their native country.

THE PILINUT

The pilinut *(carnarium ovatum)*, or Javanese almond, another tropical nut highly appreciated in the Orient, has recently been introduced into the United States from the Philippines, and by immigrants from Asia and the East Indies. The tree is a native of the East Indies. The nuts are spindle-shaped, with a triangular shell which is very thick and hard, and encloses a white, oily kernel of soft texture, almost melting in the mouth. On account of the heavy shell, the meat forms a small percentage of the fruit.

THE SAPUCAIA or PARADISE NUT

The sapucaia, or paradise nut *(lecythis zabucajo)*, is borne by a tree similar to that of the Brazil nut, though a little larger. It has a rough shell, about two inches long, not so curved as the Brazil nut. It is of fine quality and texture and has a delicate flavor, but has not yet become common in the United States.

The sapucaia, like the Brazil nut, is produced in an urn-shaped, woody capsule, which has received the name of "monkey pot," for the reason that when these capsules ripen, the lid at the top is suddenly liberated, emitting a sharp sound, which notifies the monkeys that the nuts are falling and that the first on the ground becomes the fortunate possessor of the largest number. In New York City these nuts are sold under the name of "Paradise nuts," and are very much appreciated for their rich, creamy flavor.

THE SOUARI

The souari, or tropical butternut *(caryocar nuciferum),* is a native of British Guiana, but is very seldom found in the markets of the United States. It is seen more frequently in European seaports.

The shell of the nut is of a deep brown color, embossed, as it were, with smooth tubercles. They are from two to two and a half inches, or more, in their broadest diameter. The kernel, or meat, is pure white, soft, rich and oily, with a pleasant flavor.

There are many more varieties of delicious nuts growing in the immense tropical forests covering the valleys of the Amazon and Orinoco Rivers, and their tributaries. The nuts imported so far come only from points near the seashore, as there are no transportation facilities established from interior points. The production of nuts in this vast territory, as large as the entire Mississippi Valley, must be enormous. Future generations undoubtedly will find there an inexhaustible supply of nature's most concentrated food products, far surpassing all animal food products in nutritive and hygienic value.

CHAPTER IV

VEGETABLES

Vegetables, especially the green leaf varieties, also play an important part in the nutrition of man, because they furnish the necessary vitamins and alkaline elements. In all instances where the diet consists largely of cereal foods, or flesh meat, a liberal supply of green vegetables and succulent plants is absolutely necessary to prevent acidity of the blood. In places where fruits cannot be grown successfully and in sufficient quantities, vegetables are indispensable to a properly balanced diet.

It is interesting to note the polaric distribution of the mineral elements during the various stages of plant growth, and the wonderful synthetic processes which characterize the vegetable kingdom as the laboratory of nature.

The roots, which are rich in carbohydrates, contain a well proportioned amount of all the mineral elements necessary to growth, although we often find that phosphate potash, sodium chloride, magnesia and silica predominate. An analysis of the stems of leaves shows a considerable amount of lime and iron, which give them stability and color. Iron plays an important part in vegetable life, as chlorophyl granules cannot be formed without its presence. If plants are allowed to grow in solutions free from iron, the leaves are colorless, but become green as soon as iron is added to the fluid in which the roots are immersed. The importance of iron in the human body has been referred to in a preceding chapter.

The seeds of plants contain a large amount of phosphoric acid, potash and magnesia. These elements stimulate the growth of young plants until their roots and leaves are sufficiently developed to extract nourishment direct from the soil and air.

The leaves and tender stems of vegetables, containing the largest percentage of alkaline bases, are absolutely essential, not merely as garnishes, but as a substantial feature of our dietary, especially if the latter consists of more or less demineralized cereals, meat, fish, eggs and artificial sweets.

That the great dietetic and hygienic value of vegetables is not yet fully appreciated by the American people is shown by the fact that of the total expenditure for food, only seven per cent goes to the purchase of vegetables of all kinds. Furthermore, a large part of their nutritive value is lost by irrational preparation.

Although it may almost appear like an insult to the intelligence of people to suggest that the organic salts should be retained, yet in this so-called advanced age it is amazing to see how comparatively few give proper attention to this matter. The average housewife generally cooks her vegetables with too much water, and then drains them, not realizing that the organic salts are dissolved in the water, thereby leaving little nutrition and mostly bulk. In addition to this, in order to satisfy the craving excited by the loss of the organic salts, table salt and spices are used.

The best way to insure a liberal supply of alkaline bases and vitamins is to eat a large dish of salad every day, consisting of lettuce, cress, cabbage, cucumbers, grated carrots, celery, sliced tomatoes, or whatever suitable vegetables are available. Lemon juice, instead of vinegar, should be used as a condiment.

As has been pointed out in Chapter XV, the hygienic value of the vegetables depends on the kind of fertilizers that have been applied, on various chemical compositions of the soil, and the consequent effect upon the growth of the plant. Heretofore to dietitians a vegetable has been merely a vegetable, regardless of the character of the soil that nurtured it. Only virgin soil, or its equivalent, can produce food rich in the necessary mineral elements, while manures and other animal fertilizers deteriorate rather than renovate the soil. Such fertilizers, carrying a large amount of nitrogen in the form of ammonia, produce plants composed chiefly of ammoniacal albumen, lacking in alkaline bases. And human tissue built from such plants, or their fruits, is abnormally constituted and subject to rapid decay. Nearly all the commercial fertilizers contain a surplus of nitrogen, potash and phosphoric acid which induce a rank and rapid growth of vegetation, at the cost of quality of the product. Unfortunately, it is almost impossible for the average city dweller to know the source of his vegetable supply, hence a tentative solution of this important problem is the family garden.

In order to better distinguish the characteristics and chemical

composition of the vegetables generally grown for human consumption, they may be divided into four classes:

Class A, *Fruit bearing vegetables,* chiefly grown for their fruits, while their stems and leaves are used as fertilizers. They include the following varieties:

Chayote	Peppers
Cucumbers	Pumpkins
Eggplant	Squashes
Melons	Tomatoes
Okra or Gumbo	Vegetable marrow

Class B, *Green Vegetables:*

Artichokes	Kale
Beet leaves	Kohlrabi
Broccoli	Lettuce
Brussels sprouts	Mustard
Cabbage	Parsley
Cauliflower	Rhubarb
Celery	Sorrel
Chard	Spinach
Dandelion	Watercress
Endive	

Class C, *Roots, Tubers and Bulbs*

Succulent Roots and Bulbs:

Beets	Rutabagas
Carrots	Turnips (white)
Celery root	Kohlrabi
Chives	Leek
Parsnips	Onions
Salsify (oyster plant)	Garlic
Black salsify	Asparagus
Radishes	Horseradish

Starchy Roots and Tubers:

Potato	Dasheen
Sweet potato	Taro
Jerusalem artichoke	Yam
Arrowroot	Yautia
Cassava	

Class D, *Mushrooms, fungi, lichens, algae.*

THE CHAYOTE

The chayote *(sechium edule)* a vigorous, climbing, perennial plant of the cucumber family, is native to Mexico and Central America, but is now cultivated as a garden vegetable in warm regions in many other parts of the world. The fruit has a mild, but agreeable flavor, and, in the best varieties, an excellent fibre-free texture. It has a single, large, flat seed, which is without a hard seed coat, and, unless desired for use as a table delicacy, the seed is not removed, but is cooked or baked with the rest of the vegetable. Chemical analysis shows the fruit to contain from 5 to 8 per cent carbohydrates, and from 1 to 2 per cent of protein. The fruits may be eaten when immature, but the quality improves as they approach maturity, indicated by firmness of the flesh, as it hardens during the ripening process.

The chayote can be grown much further north as an annual than as a perennial, since even the roots are easily killed by freezing. It has been grown and fruited as far north as the State of Washington, and as many as fifty fruits have been produced on a single vine when the first frosts did not appear until late in November.

THE CUCUMBER

The cucumber *(cucumis sativus)* appears to be indigenous to southern India, but has been cultivated from the earliest historic times in Syria and Egypt. While the food value of the cucumber is low, containing as it does 95 per cent water, it is nevertheless very refreshing and rich in organic salts, especially potash, lime, magnesia, and iron. To get the benefit of these valuable alkaline elements, it should be eaten frequently, like a melon, without the addition of table salt. Recently a number of very delicious varieties of the cucumber have been developed.

The *gherkin* is a small size variety of cucumber, used principally for pickling, a process which, of course, destroys its hygienic value.

THE EGG PLANT

The egg plant *(solanum melongena)* is a native of the East Indies, but is now a common fruit in the West Indies, southern Europe, and throughout the United States. The fruit is egg-

shaped, deep purple, and often reaches the size of a cocoanut. It grows like a melon on a vine, and is usually prepared for eating by cutting it in slices which are broiled or fried. Its composition is:

Water	93.00	per cent
Protein	1.13	" "
Fat	0.30	" "
Fiber	0.70	" "
Carbohydrates	4.27	" "
Mineral matter	0.60	" "

MELONS

Melons *(cucumis melo)* were originally found wild both in India and Africa. They were introduced into southern Europe about the beginning of the Christian era. Numerous varieties are now grown in North America, including the Musk Melon, Casaba, (or Winter Melon), and the Cantaloupe, named from Cantaloupe, Italy.

The WATERMELON *(cucumis citrullus)* is a native of tropical Africa, and was first cultivated by the ancient Egyptians. From the valley of the Nile its cultivation spread over all the continents. It still constitutes a large portion of the food of the natives of Egypt during the hot months of the year.

The watermelon is one of the largest of our fruits, often weighing from thirty to forty pounds. Melons of 90 to 100 pounds have been reported from regions that make a specialty of this fruit.

The fruit has a hard, green rind, enclosing a rich, delicious rose-colored pulp, of sweetish taste, for which it is highly prized. The vines, which make good fertilizers, often cover the entire field at the time of fruiting. They grow best on a sandy, well-fertilized soil, in countries that have an abundance of sunshine during the summer months. Many varieties of watermelon are now offered by seed men, among which are: the Cuban Queen, the Iceberg, the Ice Cream, the Excel, and the Klondike.

THE MUSK-MELON, (or cantaloupe), has been grown in the hot Eastern countries from time immemorial. It is a large, yellow, or yellowish-green fruit, with a highly flavored, sweet pulp, of delicate taste and odor. The best known varieties in the United States are the Rocky Ford, upon which the Colorado cantaloupe industry was established (also now grown extensively in Califor-

nia), the Tip Top, the California Large Nutmeg and the Persian Melon.

The Casaba (or winter melon), comprising several types, such as Honey Dew and Golden Beauty, is one of the most interesting and promising of melons grown in California. On irrigated land, in comparatively frostless places, these melons can be sowed in May or June and find ample autumn heat and freedom from frost to reach perfection. The ripe fruit remains in good condition for months, without cold storage. They can be conveniently stored in a shed, or in a cellar. Although the exterior portion of the rind may show signs of withering, the flesh usually remains sound.

The average composition of the edible portions of the cantaloupe and watermelon is given in the following table:

	Cantaloupe	Watermelon
Water	89.50 per cent	92.40 per cent
Protein	0.60 " "	0.40 " "
Fat		0.20 " "
Carbohydrate (sugar)	7.20 " "	6.70 " "
Fiber	2.10 " "	
Mineral matter	0.60 " "	0.30 " "

The alkaline elements predominate, potash, lime and iron constituting a large percentage. Melons, containing about 90 per cent water, furnish food and drink combined. They are much more refreshing and wholesome than the artificial soft drinks now offered for sale everywhere. Melons supply the purest kind of water sweetened with natural fruit sugar, and enriched by the valuable organic salts and vitamins. Use more melons instead of soft drinks to keep cool in hot weather.

OKRA, or GUMBO

Like the melon, okra *(allium cepa)* was first cultivated by the ancient Egyptians, and for many years has been in constant use in the Mediterranean countries. *Gumbo* is its Spanish name. The parts used are the pyramidal seed pods which are gathered while green. They contain a large proportion of a mucilaginous substance, which forms a jelly when boiled in water.

Okra is mostly used for vegetable soup, but it may be eaten raw by those who prefer uncooked food. It is grown from the

seed, planted in rows, or hills, like corn. In appearance it resembles the cotton plant. Its composition is as follows:

Water	90.0 per cent
Protein	1.6 " "
Fat	0.2 " "
Carbohydrates	7.4 " "
Fiber	3.4 " "
Mineral matter	0.6 " "

The mineral matter shows a large portion of soda and lime.

PEPPERS OR CAPSICUMS

Peppers are the fruits of several species of *capsicum,* belonging to the class of nightshades. The best known varieties are the Bell Peppers, a West Indian species, bearing a large green capsule; and the Chillies, having small pods ½ to ⅔ of an inch wide and from three to five inches long, of deep orange-red color. The name "chillie" is of Mexican origin. Although peppers are natives of the tropics, they are grown extensively in the warmer climates of the United States, and are chiefly used in combination with other vegetables, or as a pickling spice. Green peppers promote the secretion of gastric and pancreatic juices, and when used moderately, prevent flatulence.

The active principle in peppers is a volatile alkaloid, called "capsicine." In hot climates peppers are extensively used as a stimulation to the appetite.

The Perfection Pimiento is the popular variety now grown in Orange County, Southern California, and Georgia. It is about four or five inches long and about three inches in diameter through the cove end. It is grown from seed sowed directly in the fields during the latter part of March. Later the plants are thinned out twenty inches apart in rows, the latter being spaced three feet apart. The seed of the pimiento was introduced from Spain. The pimiento is harvested in October and November, a part of the crop being canned and part dried. It bears prolifically, yielding from five to eight tons per acre.

On account of their alkaloid contents, peppers should be used very sparingly and only in their fresh state. Canned and pickled foods, prepared with peppers, should be strictly avoided.

THE PUMPKIN, SQUASH, AND VEGETABLE MARROW

Pumpkins, squashes and vegetable marrow belong to the natural order of *cucurbita,* or gourds. There are over fifty varieties grown, all of similar chemical composition.

Pumpkins often grow to a large size and are chiefly used for feeding stock. A considerable quantity is canned or evaporated. Pumpkin flour, used extensively in making pies, is manufactured from the evaporated pumpkin, which is ground into a powder. Pumpkins are preferable when baked.

The word "squash" is adapted from an American-Indian word, and, in an indefinite way, is generally applied to various members of the cucurbita family. The so-called "summer squashes" include the following varieties: Summer Crookneck, Patty Pan, Grant Summer, Bush Ford Hook, Mammoth White Bush, Early Yellow Bush, Early Golden Bush, Summer Bergen, Pineapple, Turben, etc.

The principal varieties of winter squash are the Gregory Delicious, the sweetest and finest flavored squash in cultivation; the Hubbard, a curiously shaped sort with dark green skin and rich orange-yellow flesh; the Warted Hubbard, the Boston Marrow, popular throughout the New England states, and the Winter, or Canada Crookneck squash.

Vegetable Marrow *(cucurbita ovifera),* resembling the cucumber in shape, is more commonly grown as a garden vegetable in England than in the United States. One variety grown here, known as the Crown Gourd, or Custard Marrow, bears a flattened fruit with scalloped edges, and is sweeter than the true marrow.

The average chemical composition of these three vegetable fruits is as follows:

	Pumpkin	Squash	Vegetable Marrow
Water	93.10 per cent	88.30 per cent	91.90 per cent
Protein	1.00 " "	1.40 " "	1.00 " "
Fat	0.15 " "	0.50 " "	0.10 " "
Carbohydrate	5.20 " "	9.00 " "	5.20 " "
Fiber	1.10 " "	0.80 " "	0.70 " "
Mineral matter	0.60 " "	0.80 " "	0.50 " "

The alkaline elements of potash, soda and lime make up a large percentage of the mineral matter.

THE TOMATO

The tomato *(lycopersicum esculentum)* is the fruit of the tomato vine, which is a member of the nightshade family. It probably comes to us from Central America or Peru. It was formerly known as the ''love apple'' and first grown mainly for ornamental purposes. It was brought to Europe in the sixteenth century, and is now grown extensively on the shores of the Mediterranean Sea, where the climate is admirably adapted to its propagation.

It is now extensively cultivated in nearly all portions of the United States. In order to allow sufficient time for the tomato to fully ripen, the harvest is usually hastened by sowing the seed in a hotbed, and setting out the young plants as soon as danger from frost is past. In southern, frost-free countries, the tomato is perennial, and can be grown at any time of the year.

The average chemical composition of the tomato is as follows:

Water	93.0	per	cent
Protein	1.0	''	''
Fat	0.3	''	''
Carbohydrates (including sucrose, dextrose and levulose)	4.0	''	''
Fiber	0.7	''	''
Mineral matter	0.6	''	''

The mineral matter is strongly alkaline, containing a large proportion of the salts of potash, lime, magnesia and iron.

Many vegetables and fruits, including the tomato, owing to the presence of citric acid and other similar acids, are not alkaline when eaten, but are potentially alkaline, as these acids, after being burned in the body, leave behind an alkaline salt. The acid of the tomato, about 0.5 per cent, is mostly malic, combined with a small amount of citric, and a trace of oxalic and other organic acids.

It is a mistake to exclude the tomato from the diet of people suffering from gout and rheumatism because of the oxalic acid it contains. The amount is too small to have any effect upon the system. Besides, this acid always occurs in connection with alkaline bases. The tomato eaten in its natural state, especially in the

form of combination salads, is highly beneficial in reducing the acidity of the blood and removing uric acid from the system.

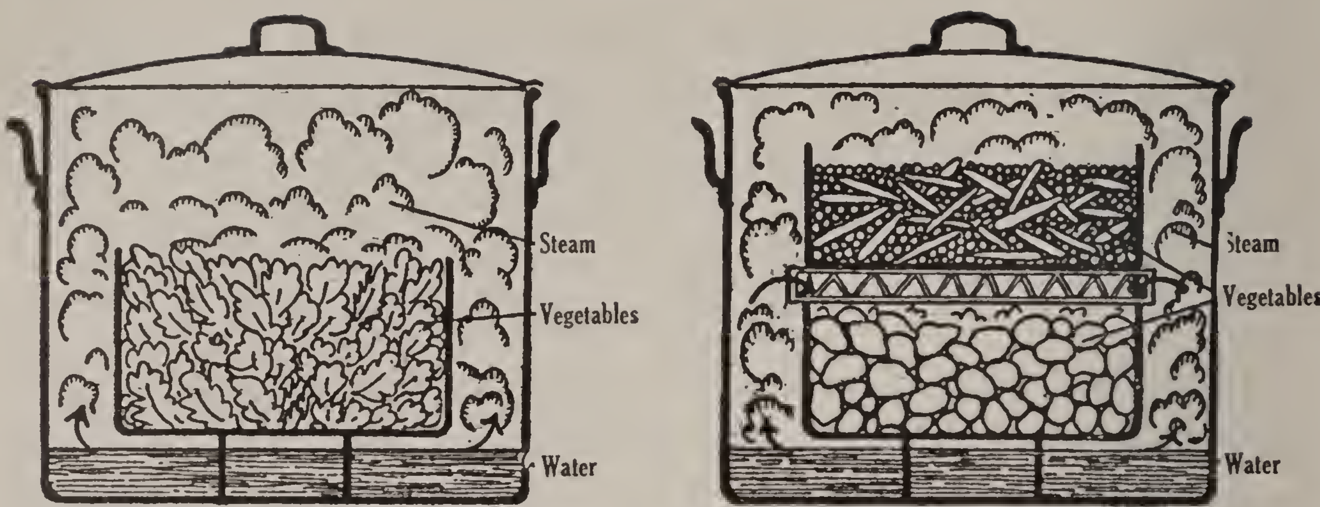
A large proportion of the tomato crop in the United States is canned, and is also used in the manufacture of tomato catsup.

GREEN LEAF VEGETABLES

The green vegetables contain only a small percentage of solid nourishment, but they are rich in alkaline salts, especially soda, lime, and iron, and, therefore, from a hygienic point of view are highly important. The leaves, consisting of a frame work of fibrous tissue, upon which the protoplasmic cells are spread out, serve principally for the respiration and nutrition of the plant, by exposing the chlorophyll-bearing cells to the air and light. Besides, the leaves contain an appreciable amount of organic acids and vitamins, which are important factors in promoting the performance of the physiological functions of the body. The salts enter the vegetables by their roots in the form of "ions," or electrically charged molecules, and circulate as such through their fluids and tissues. It is here that the great importance of organic salts becomes apparent, as the function of food is not merely to be burned up, and to furnish calories, but to supply vital electricity in the form of negatively and positively charged ions. The calories of food are really but of secondary importance. Digestion, assimilation, and elimination—in fact, all processes of life and growth—depend upon the presence of electrolytes, or electrically charged ions. A constant osmotic pressure between the cells is maintained by the organic salts, which are just as important for the life of the cells as proteins and vitamins.

In dried vegetables the organic salts are no longer found in their ionized form, and have lost some of their physiological value. Again, when vegetables are boiled, they lose a large amount of soluble nutrients—5 to 10 per cent protein; 30 to 50 per cent of the carbohydrates; and about 50 per cent of the organic salts. They should, therefore, be steamed or baked, or at least stewed in their own juices, if they are not eaten raw.

Fresh vegetable juice, made by grinding the vegetables in a food chopper, and pressing the pulp through cheese cloth, have a great therapeutic value and may often be used in infant feeding. Owing to their high content of alkaline salts and mild organic



Vegetable steamers with perforated metal containers or wire baskets for preparing one or several kinds of vegetables, with the least possible impairment of their nutritive value.

acids, fresh vegetable juices, when absorbed, exert a salutary influence on the composition of the blood by increasing its alkalinity.

The protein in green vegetables is small comparatively, but the smaller and younger the leaves, the richer they are in this food principle.

Complete analyses of most vegetables are to be found in the general tables (in the appendix).

The principal varieties of green leaf vegetables are briefly described here.

The Artichoke *(cynara scolymus)*, which belongs to the thistle family, is cultivated for the sake of its immature flower heads, which are served chiefly either steamed, or cooked in water or milk. When the leaf stalks are blanched by tying them up, the term "chard" is applied to the white and tender leaves.

Cabbage *(brassica oleracea)* and its varieties, in which may be included broccoli, brussels sprouts, red cabbage, savoy cabbage, cauliflower, chard, kale, kohlrabi, have been mostly cultivated from the wild cabbage, or colewort. They all contain a considerable amount of sulphur, lime and iron. The chemical analysis shows on an average of about 90 per cent water; from 2 to 4 per cent protein; 5 to 10 per cent carbohydrates; 0.5 to 1.5 per cent fiber; and from 0.5 to 2.5 per cent mineral matter. These properties vary greatly in different kinds of soil.

Celery *(apium graveolens)* which grows wild in damp and marshy places throughout Europe and Asia, has been cultivated since the time of ancient Greece. There are now about forty va-

rieties, and many more sub-varieties. The tender blanching leaf stalks are the result of long years of cultivation. On the continent of Europe, a variety, known as "celeriac" is cultivated, to which reference will be made under "Succulent Roots and Bulbs." Celery is rich in potash, lime, sulphur and chlorine, while celeriac is especially rich in sodium, iron and chlorine.

DANDELION *(leontodon taraxacum)* leaves when young and tender are very valuable for salads on account of their richness in alkaline elements. They are especially recommended for cleansing the kidneys.

THE ENDIVE *(chicorium endivia),* sometimes called "winter lettuce," belongs to the same family as the dandelion. It was cultivated at an early date in the Orient, and is found wild in all countries surrounding the Mediterranean Sea. The green tops make excellent salad.

THE CHICORY *(chicorium intybus)* is closely related to the endive and dandelion. The leaves are rather bitter, but are used in salads. Under cultivation a large root is developed, which is used as a coffee substitute.

LETTUCE *(lactuca capitata)* is the most important of the succulent vegetables. It was cultivated by the ancient Greeks and Romans, and used as a salad plant. There are several species and about one hundred varieties, of which cos lettuce and cabbage lettuce are the most widely used. The former has large upright leaves, while the latter has round leaves of a more spreading character, which grow nearer to the ground. The juice of the leaf is milky and possesses mild, soporific properties, on account of the presence of a small amount of lactuarium, or lettuce opium. Lettuce on an average contains:

Water	94.00	per	cent
Protein	1.30	"	"
Fat	0.40	"	"
Carbohydrates	2.70	"	"
Mineral matter	1.00	"	"

It is strongly alkaline, being especially rich in potash, lime and iron. A few crisp leaves of lettuce should be eaten daily.

MUSTARD GREENS *(sinapis),* the leaves of the wild mustard plant, may be used as salads, or cooked alone or in combination with other vegetables. They contain some of the essential oil of mustard, which gives them a pungent taste.

Parsley *(apium petroselinum)* is another herb which is mostly used for flavoring in salads and soups. All parts of the plant contain an oil, to which its flavor and other properties are due.

Rhubarb or Pie Plant *(rheum rhaponticum)* is a valuable article of diet, rich in organic salts and fruit acids, which include about 2.5 per cent oxalic acid. The stems are generally cooked and used for sauces and pies. As a sweetening, honey, raisins, or dates should be used instead of refined sugar.

Sorrel *(rumex-acetosa)* is generally used as a salad, in combination with endive, lettuce and similar vegetables. It contains much free acid, especially tartaric and oxalic—of the latter, between three and four per mille, mostly in the form of oxalate of calcium and potassium. It is exceedingly rich in iron.

Spinach *(spinacea oleracea)* comes to us from northern Asia, and was even common in Biblical times. It was introduced into Europe during the sixteenth century. It is rich in sodium, calcium, and iron, and, therefore, an excellent blood builder, especially if eaten uncooked, as a salad. It is usually boiled in water, but steaming is to be preferred, as the salts may thereby be preserved. Spinach, if grown in well fertilized soil is one of the most excellent sources of the vitamins and iron.

Two varieties of the plant are grown: the winter or perpetual spinach, having small prickly leaves; and the smooth leaf variety, having thick, fleshy and crumpled leaves.

New Zealand Spinach *(tetragonia expansa)* is a hardy perennial in sub-tropical countries, and a native of Australia. It is now grown in many parts of the United States and England. It is capable of bearing drought better than ordinary spinach, often replacing the latter where its growth fails.

Watercress *(nasturtium officinale)* is the most important of the cresses. It grows near ditches and ponds, and is also widely cultivated. The leaves have a moderately pungent taste, but are most valuable for combination salads, on account of their anti-scorbutic properties. Watercress contains all the essential vitamins. It is rich in the alkaline elements, especially potassium, calcium and magnesium; also in sodium and chlorine. The sharp taste of watercress is probably due to the large amount of sulphur found in the leaves.

SUCCULENT ROOTS AND BULBS

The succulent roots are so designated on account of their comparatively large percentage of water, which ranges from 75 to 90 per cent. They are not as rich in alkaline elements as the green vegetables, but they contain a sufficient amount to be most valuable adjuncts of a dietary, if properly prepared. Beets, carrots and some of the radishes come nearest to the green vegetables in alkaline properties.

Beets *(beta vulgaris)* are cultivated in many varieties throughout the temperate and sub-tropical zones. The most common are the white, or yellow, and the red beets. The sugar beet is largely grown in France, Germany, Belgium, America, and other countries, for the manufacture of sugar. A considerable portion of the carbohydrates contained in beets is chemically known as cane sugar, which in the best varieties often amounts to 20 and even 30 per cent. Sugar beets, if cut into small pieces and boiled in just enough water to cover them, resemble very much stewed apples, and the water in which they are boiled makes a wholesome, nutritious drink, if sufficiently cooled. Here one has the natural sugar *(sucrose)* of the beet and most of the alkaline elements, which are completely removed in the refining process.

Finely-grated white or red beets are often used uncooked for salads, in combination with other vegetables. They may also be baked, like potatoes, which is the best way to prepare them for those whose digestive organs are impaired. If beets are cooked in water, the latter should always be carefully preserved, as it contains a large portion of sugar and organic salts. As previously mentioned, beet tops and stems, especially those of the red variety, resemble in beneficial qualities those of the green vegetables, and they should, therefore, be always used while fresh.

Carrots *(daucus carota)* have been cultivated for more than two thousand years in Europe and western Asia. By persistent cultivation the root of the wild plant, which is white, slender and hard, with an acrid taste, has been transformed into a thick, fleshy, succulent root of orange color, with a sweet and agreeable taste. There are now about thirty varieties. Young carrots are more satisfactory than old ones, as the latter have a tendency to become woody, especially at the core. As in beets, the carbohydrates of the carrot consist of a large percentage of sugar, often

as much as 12 per cent, although 6 to 7 per cent constitutes an average. The mineral matter is rich in all the alkaline elements—potash, soda, lime, magnesia and iron—making up about 75 per cent of the total amount. If carrots are finely grated, a process which breaks up the cells, a rich, juicy and sweet pulp will be obtained, which is easily digested even by the weakest of stomachs. If the pulp is pressed through cheese cloth and carefully strained, it may occasionally be given to infants. Like beets, carrots are best steamed or baked, in order to avoid appreciable loss in organic salts. With due care they may also be boiled or stewed.

Radishes *(raphanus sativus)* are grown in over forty varieties, in all kinds of shapes and colors. The most commonly known in the United States are the small ones with red exterior and white flesh. The roots have a very fine flavor and when young are crisp, juicy and tender; but when old, they contain much woody fiber, and are difficult to digest. The pungent flavor of radishes is due to organic compounds, containing sulphur, similar to the essential oil in mustard.

In addition to the small pink and red radishes, there are some large varieties cultivated, among which the Japanese white radish and the black radish are best known. Radishes are preferably eaten in their natural state or grated in combination salads. The mineral matter of the larger radishes especially abounds in potash, lime, iron and sulphur. Radish leaves can be used for greens, or if very tender, added to salads.

Turnips *(crassica napus)*. Innumerable varieties of turnips are grown throughout the temperate zones, of which the most common are the white and yellow turnip, and the Swedish turnip, or rutabaga. In summer the early white varieties are usually preferred, while during winter the yellow turnips are more frequently consumed. The flavor of the turnip, like that of the cabbage and radishes, is primarily due to compounds of sulphur. In cooking, these pungent substances are broken down to some extent and pass off into the air. The carbohydrates of turnips are made up of glucose, sugar, pectose, pentosans and crude fiber. The mineral matter is rich in potash, soda and magnesia.

Kohlrabi *(brassica caulorapa)* or turnip-rooted cabbage, is another variety of the turnip and cabbage family, in which the reserve food of the plant is stored up in a tuber-like enlargement

of the stem, just above the ground. In flavor it is more delicate than either the turnip or cabbage. It can be either baked or cooked with other vegetables, to which some of the kohlrabi leaves may be added.

Parsnips *(pastinaca sativa)* were quite familiar to the Romans, as they appear in ancient frescoes at Pompeii. They belong to the same botanical order as carrots, and resemble them in form and general habit of growth, but the flesh is of a light cream color, while the flavor is quite distinctive and very pronounced. The carbohydrates which make up about twelve per cent of the solid nourishment consist of 5 to 7 per cent of starch in exceedingly fine granules. The sugars vary from 3 to 7 per cent; gummy substances, 5 to 6 per cent; protein, 1 to 1.5 per cent; cellulose, 1.5 to 2.5 per cent; mineral matter averages 1.4 per cent, in which potash, lime and magnesia predominate.

Celeriac *(apium graveoleus)* is the name applied to one variety of celery, which is chiefly grown for its roots. In Europe it is by far the most common form of celery, but it has never been extensively cultivated in the United States. The roots resemble the parsnip in color, but are more or less globular in shape, like turnips. For this reason the vegetable is often called turnip-rooted celery. The composition is very much like that of the other succulent roots. Potash, sodium and chlorine predominate in the mineral matter. Celeriac has a pronounced celery flavor, due to an essential oil, like that found in the seed, which is rather strong in the raw root. If baked and sliced, it makes a wholesome and delicious addition to salad.

Salsify *(trapagon sorrifolius)* is the name generally given to three different kinds of vegetables: the common white salsify, known also as oyster plant, or vegetable oyster; the black salsify, the *Schwarz Wurzel* of the German, and the Spanish salsify. Both common and black salsify resemble the other succulent roots in general character. The principal carbohydrate stored in black salsify is inulin, which is transformed into sugar by the action of hydrochloric acid in the stomach. Inulin replaces starch in many plants as reserve carbohydrate, and from a physiological point of view it serves the same purpose in the body. The leaves of salsify, if young and crisp, may be eaten as a salad. In the mineral matter

of this vegetable, potash, lime, magnesia and iron constitute the larger portion.

Onions, Garlic, Leek and Chives are all members of the large onion family *(allium)* and are characterized by the presence of an acrid volatile principle, an oil-like organic compound of sulphur, which gives them very valuable purifying properties. They form an important class of vegetables, whether used in the cooked or raw state. The onion *(allium cepa)* was cultivated for thousands of years by the ancient Egyptians and Hebrews. It was said that the onion was worshiped in Egypt before the Christian era, and that nine tons of gold were spent in buying onions for the workmen during the building of the pyramids.

Onions grown in warm countries have a mild flavor, owing to a smaller amount of the acrid principle than is contained in those of colder countries.

In the United States the onion holds third place among the truck crops. About 15 million bushels are raised annually. Large quantities are also imported from southern Europe, Bermuda, and the West Indies. Onions, like lettuce, have a soporific effect.

Chives and leeks, two other varieties of the onion family, develop very small bulbs and are usually grown for their leaves; leeks being used as a green vegetable, or pot herb, and chives mostly for seasoning.

Garlic *(allium sativum)* is the most strongly flavored of the plants of the allium family. It is grown extensively, and is much esteemed in southern Europe. It produces a collection of small bulbs, called cloves, in place of one large bulb. Some of the mixed varieties grown in the Mediterranean region are eaten as vegetables, but in this country garlic is generally used for flavoring. Rightly used, it may add to the palatability of salads and many other dishes.

The chemical composition of onions varies according to the stage of growth and variety, but is similar to that of the other succulent roots. Onions, if stored for awhile, lose some of their water and consequently change the proportion of their solid contents. The average composition of onions is as follows:

Water	60.0 to 90.0	per cent
Protein	1.0 to 5.0	" "
Fat	0.1 to 0.8	" "
Carbohydrates	5.0 to 25.0	" "
Mineral matter	0.5 to 1.2	" "

On account of their large contents of lime and iron, onions and leeks are especially beneficial to anemic and diabetic people.

Asparagus *(asparagus officinalis)* was cultivated from the earliest Roman times and is grown throughout the temperate zones. It is valued for its young and tender shoots, which are generally boiled, but which may be also used uncooked in combination salads. Asparagus is especially rich in sodium, calcium, iron and sulphur. It also contains a nitrogenous principle called "asparagin," which has diuretic properties. The strong odor of the urine after eating asparagus is caused by a volatile sulphur compound.

Horseradish *(cochlearia armoracia)* is a plant of the mustard family, which is cultivated throughout the north temperate zone; it is also frequently found wild in the United States. The root is long, rather slender, and has a sharp, peppery flavor owing to the presence of an essential oil, which is dissipated by drying. It resembles in general character the oils in the radish and other members of the mustard family. Horseradish is generally used grated, taking the place of a condiment rather than a food in diet. Taken moderately in salads, and without vinegar, it promotes the flow of the digestive juices. It may also be cooked with other vegetables.

Chemical analysis shows:

Water	86.4 per cent
Protein	1.4 " "
Fat	0.2 " "
Total Carbohydrates (mostly starch)	10.5 " "
Mineral matter	1.5 " "

The mineral matter consists chiefly of potash, lime, magnesia and sulphur. Containing as it does a very large amount of sulphur in an organized form, horseradish is one of the most valuable antiscorbutic vegetables, besides being of value in chronic rheumatism and dropsical conditions.

Ginger *(zingiber officinale)* is the underground root stock of the ginger plant, which is a native of India, China and the Moluccas, but is now cultivated to a very large extent in the West Indies. Jamaica ginger is probably the best known variety. The plants are set out in March or April, flower in September; the seeds are

formed in January, after which the leaves wither. The roots are then dug up and trimmed, washed and treated with boiling water to prevent germination, and rapidly dried. Thus prepared, they constitute the unbleached, or black ginger White ginger is prepared from the best peeled roots, which are carefully dried in the sun.

Ginger is a stimulating aromatic spice, much used in baking. The ginger root consists of:

Water	85.6	per cent
Protein	1.0	" "
Fat	0.6	" "
Sugar and starch	11.4	" "
Crude Fiber	1.0	" "
Mineral matter	1.4	" "

Of the total fat, about half consists of the ethereal oil which, together with a pungent, non-volatile constituent, called gingerol, gives to ginger its characteristic flavor.

Ginger may be used occasionally in very small quantities as a spice in bread, but confections and beverages made from ginger should be avoided.

SASSAFRAS *(sassafras variifolium)* is a small tree growing along the Atlantic Coast, and in the interior of the United States. The bark of the small stems, and especially the root, yields a flavoring extract valued in the preparation of beverages and confectionery. A tea made from the roots, once known as "saloop," is still used to some extent in the home, and commercially.

STARCHY ROOTS

THE POTATO *(solanum tuberosum)* is a member of the nightshade family, which includes the tomato and eggplant, and also tobacco. Its tubers constitute a staple food for millions of people all over the globe; and at present, next to cereals, it is probably the most important food product of the human race. It is a native of the elevated valleys of Chili, Peru, and Mexico. It was brought to Europe between 1580 and 1585, first by the Spaniards, and later by the English, at the time of Sir Walter Raleigh's voyages to Virginia. Raleigh first cultivated it in Ireland, where he had large estates, but the potato did not come into general use on the continent until the middle of the eighteenth century. As the potato yields twenty to thirty times the weight of wheat,

barley or oats, its great value as an almost indispensable staple food becomes apparent. In 1915, the potato crop of the United States amounted to about 360 million bushels, valued at 220 million dollars, or about 60c per bushel. Part of the annual crop is used for stock food and manufacturing purposes, but by far the largest portion finds its way in various forms to our tables.

The relatively large yield of the potato in the United States is shown by the following figures, giving a ten years' average: Potatoes, 92 bushels per acre; corn, 26 bushels per acre; wheat, 14.3 bushels per acre. These figures are far exceeded by European statistics, which report an average yield of 190 bushels in Germany; 216 bushels in Denmark; 295 bushels in Holland, and 305 bushels in Belgium. Germany, however, leads all European countries in the total amount of potatoes produced, in the percentage of acreage devoted to their cultivation, as well as in the annual per capita consumption. About sixty million bushels of an inferior variety of the potato are raised annually for distillation into alcohol in Germany for industrial purposes.

The potato, strictly speaking, is not a root, but a modified stem, shortened and thickened to form a storehouse for material held in reserve for the propagation of young plants. By making a cross section through a potato, four distinct divisions may be seen: first, the skin; second, the cortical layer, which varies in thickness from one-eighth to one-half an inch and contains a higher percentage of the mineral matter and other nutrients than the tuber as a whole. The interior of the potato is made up of the outer and inner medullary, or pithyareas. The outer one forms the main bulk, and contains the greater portion of carbohydrates, varying with the state of growth; while the inner area, appearing in a cross section like a star, sometimes called the core, contains slightly more cellulose and water than the outer portion. According to a French investigator the different parts of the potato are made up as follows: skin, 8.8 per cent; cortical layer, 36.2 per cent; outer medullary area, 34 per cent, and inner medullary area, 15 per cent.

The skin of the potato contains a small proportion of an alkaloid, called *solanin,* which is removed with the peel, or destroyed by heat, when the tubers are baked or boiled.

According to Dr. William Tibbles, an English authority, who

collected over thirty analyses of the potato, its average composition is as follows:

Water	75.66	per cent
Protein	2.05	" "
Carbohydrates	19.94	" "
Fiber	1.02	" "
Mineral matter	1.08	" "

Phosphate of potash, magnesia and chlorine constitute the larger portion of the organic salts. The percentage of iron and lime is rather small in the potato, and it should, therefore, be eaten in combination with green leaf vegetables to make up for the deficiency. Several organic acids, such as citric and tartaric, are also found in the potato.

In preparing the potato for the table a large part of its nutriment is lost. In paring raw potatoes by hand the average loss is about 20 per cent, and not only includes all the skin and cortical layer, but also ten per cent of the flesh. The mechanical potato peeler usually removes the skin with little loss of edible material. A further loss of nearly 20 per cent occurs by boiling peeled potatoes. Boiling them in the skin, steaming them, or best of all baking them, are therefore the methods to be recommended from an economic and hygienic point of view.

During the process of boiling, the temperature of the interior of the potato is perhaps a trifle lower than that of the water. When baked, the temperature of the interior of the potato reaches 212 degrees F., but does not exceed this, if cooked only until tender. To prevent overbaking, a dish of water may be placed in the oven with the potatoes. The heat and steam break up the cell walls and release the starch, which is partially changed into dextrin, and is very readily assimilated. If the uncooked potato is sufficiently masticated, or finely grated, so that the cell walls are ruptured, the raw starch will be dissolved by the digestive juices, and at the same time the action of vitamins found in the potato will be assured.

During the World War enormous quantities of potatoes were desiccated and used in various forms by the fighting armies, especially those of the Central Powers. The dried potato is equal in nutritive value to some of the cereal flours. Potato starch, often sold under the name of potato flour, cannot well be recom-

mended as an article of diet, as during the process of manufacture the organic salts are removed.

The Sweet Potato *(convolvulus batatas)* is also extensively grown, but unlike the white potato, is chiefly a product of the warmer temperate zones, or sub-tropical countries. It constitutes an important food crop in the Gulf States, California, West Indies, Hawaii and the Philippines. It is said that Columbus on his return to Spain presented a sweet potato to Queen Isabella. Since that time it has become an important root crop in Spain, and is one of the principal root crops of the Madeira Islands. Portuguese seamen took it to Japan, where it is now one of the leading crops on the upland fields of the southwestern part of the mainland.

The sweet potato is a true root, and not a tuber. It also differs from the white potato in that its carbohydrates contain considerable quantities of sugar in the form of cane sugar, and invert sugar, or glucose. The proportion of sugar is greater in roots grown in warmer countries, and in tropical sweet potatoes sugar and starch are found in almost equal quantities. Those grown in the Middle Atlantic states do not average more than 5 or 6 per cent sugar, or about 20 per cent of their total carbohydrates. During their storage, however, some of the starch is converted into sucrose, or cane sugar, and in this respect the sweet potato resembles the banana, whose starch is also converted into sugar (mostly glucose) if stored in a moderately warm place. The average of a large number of analyses made by the U. S. Department of Agriculture is as follows:

Water	69.00	per cent
Protein	1.80	" "
Fat	0.70	" "
Carbohydrates	27.40	" "
Fiber	1.30	" "
Mineral matter	1.10	" "

Like the white potato, the sweet potato contains a considerable amount of phosphate of potash, but is richer in lime and chlorine.

Sweet potatoes are best when boiled in the skin, or baked like white potatoes. They should be cooked slowly and for quite a long time. An hour in the oven at a low heat serves to develop the best flavor. Sweet potatoes, like the white potatoes, are often desiccated, and in this form they will keep for a long time.

Arrowroot is the commercial name of a starchy food derived from the root stock of several tropical plants, natives of both the East and West Indies. The principal varieties used are *maranta arundinaca, canna edulis* and *tacca pinnatifidia;* the latter is known as *Madagascar Arrowroot,* as it is chiefly grown on this island.

The preparation of arrowroot starch consists in washing, peeling, grinding or grating the roots of the plants and straining the pulp through cloth. The strained liquid, resembling milk, is placed in a container, where the starch settles at the bottom. The liquid on top which has most of the protein and organic salts is then drained off. The residue, after it is dried, contains over eighty per cent starch and has an insipid taste. Although it is easily digested and often prescribed for invalids and convalescents, it is of little hygienic value, as it is almost entirely deficient in blood and tissue building elements.

The Jerusalem Artichoke *(helianthus tuberosus)* is a tuber of a variety of the sunflower family. It is indigenous to Canada and the upper Mississippi Valley, and was cultivated by the American Indians. It was introduced into Europe early in the seventeenth century. The name "Jerusalem" is a corruption of the Italian *gerasole,* whereas "artichoke" alludes to the artichoke flavor of the tuber.

In Europe, and to a certain extent, in the United States, it is considered a valuable plant; the bright yellow flowers at the top of the tall stalks no doubt help to make the plant attractive. It is often grown on the edge of a garden and the tubers are dug for home use. They contain on an average:

Water	78.7	per	cent
Protein	2.5	"	"
Carbohydrates	17.5	"	"
Fat	0.2	"	"
Mineral matter	1.1	"	"

The carbohydrates in the Jerusalem artichoke contain no starch, but inulin and levulin, which are closely related to starch, but are inverted into levulose. The tubers do not, like potatoes, become mealy in boiling, as there are no starch globules to swell up and absorb moisture, resulting in an expanded condition after cooking. Like the potato, the Jerusalem artichoke contains a large amount of

phosphate of potash, but a larger amount of lime and iron than the former.

The Cassava *(manihot utilissima)* is one of the tropical rivals of the sweet potato, and extensively used for human food. A dried starch product is also prepared from the cassava, which is brought into the markets of the temperate zone under the name of *tapioca.* The cassava plant, which is a bushy shrub, reaches a height of eight or ten feet and develops roots about two inches thick and about four feet long, often weighing from ten to thirty pounds.

The plant is a native of America, but is now extensively grown in India, South and Central America, Africa and the West Indies. In the United States the cassava may be grown successfully near the Gulf Coast. In some of the tropical countries the cassava furnishes the material for bread. The raw root contains some prussic acid, which is destroyed in the boiling process. The native dries and grates the boiled roots, which are then made into cassava cakes. Sometimes the roots are baked like potatoes. In the Congo the natives eat the cassava in place of bread. It often requires fully nine months for the cassava to mature, which is quite as long as wheat and longer than many of our other cereal foods. It is more productive than the potato of the temperate zone.

Tapioca, or cassava starch, is made chiefly of the cassava plant from the grated roots, *(manihot utilissima),* which are mixed with water and then filtered through cloth to remove the cellulose. The starch settles in the liquid, and while moist, is gradually heated until the starch granules are broken up, and the mass becomes agglutinated and rather firm. It is prepared for the market in three forms, viz., pearl tapioca, tapioca flake, and tapioca flour. It is evident that these products are deficient in mineral matter, which is largely lost in the water, as shown by the following table, according to analyses made by Drs. Wiley and Atwater:

	Sweet Cassava Fresh	Sweet Cassava Dried	Tapioca Average
Water	60.72 per cent	8.26 per cent	11.40 per cent
Protein	0.64 " "	1.66 " "	0.40 " "
Fat	0.17 " "	0.44 " "	0.10 " "
Starch and sugar	30.89 " "	80.06 " "	88.00 " "
Fiber	0.85 " "	4.30 " "	—— " "
Mineral matter	0.74 " "	3.28 " "	0.10 " "

Tapioca is generally prepared from the bitter cassava root. No

special analysis of the mineral matter has been made, but the chief elements present are probably phosphate of potash and magnesia.

YAMS *(dioscorea batatas)* belong to a group of about two hundred species of tropical and semi-tropical climbing plants, cultivated for their edible starch-yielding roots. They are native to southeastern Asia, and but little known in the United States. They are staple foods in Porto Rico, Hawaii, and the Philippines. The roots vary greatly in size, some being no larger than potatoes, while others attain a length of several feet, and a weight of forty to fifty pounds. The common method of growing the yam is to let the vines run on poles, carefully removing the big fleshy roots from time to time without disturbing the plant.

In appearance yams look like sweet potatoes of medium size, while in flavor and chemical composition they closely resemble potatoes. They are not as suitable as the potato for shipping, as they lack keeping qualities. For this reason they are usually left in the ground until required for use. The yam may be called the potato of the tropics, and it is prepared in much the same way. Starch and flour are also made from yams and used in tropical countries as bread making material. Yams contain:

Water	73.0	per	cent
Protein	1.8	"	"
Fat	0.2	"	"
Carbohydrates	23.3	"	"
Crude Fiber	0.6	"	"
Mineral matter	0.9	"	"

DASHEEN, TARO and YAUTIA are closely related, botanically, belonging to the Arum family, which includes also the *caladium*, an ornamental plant, known as "elephant's ear," as well as the *calla lily* and the *Indian turnip*. The three varieties all form large underground root stocks, or corms, of spherical shape, but slightly pointed toward the top, sometimes weighing over five pounds.

The root of the dasheen *(caladium esculentum)* consists of a large central root stock from which tubers branch out on all sides. They grow well in wet lands, and make a profitable root crop in soils too moist to be adapted to the growth of potatoes or sweet potatoes.

The root of TARO *(colocasia esculenta)* is a staple food throughout the South Sea Islands. "Poi," the cooked and slightly fermented paste of the grated taro, is a favorite dish of the Hawaiians.

The color of the roots varies from white, or cream color, to orange, brown, or lavender. The starch granules are very much smaller than those of potatoes and other starchy roots. The chemical composition of the three varieties is very much alike, as shown in the following table:

	Dasheen	Taro	Yautia
Water	65.7 per cent	70.9 per cent	70.0 per cent
Protein	3.0 " "	1.8 " "	2.2 " "
Fat	0.2 " "	0.2 " "	0.2 " "
Starch, sugar, etc.	28.8 " "	23.2 " "	26.1 " "
Crude fiber	0.7 " "	0.8 " "	0.6 " "
Mineral matter	1.3 " "	1.2 " "	0.9 " "

Sago, generally known as *pearl sago,* is an extracted starch prepared from a deposit in the trunk of several palms, the principal source being the sago palm, *(rhapis flabelliformis),* a native of the East Indian Archipelago. The trees flourish only in the low marshy lands of the tropics. They attain maturity as starch yielding plants at the age of about fifteen years, when the stem becomes filled with a large mass of spongy, medullary matter, around which is an outer rind consisting of a hard, dense, woody wall about two inches thick. When the fruit is allowed to form and ripen, the whole of this starchy core disappears, leaving the stem a mere hollow shell. When ripe the palms are cut down, the stems divided into sections and split up, and the starch pith extracted and grated into powder. The latter is then kneaded in water over a strainer, through which the starch passes, leaving the woody fiber behind. The starch settles in the bottom of the trough, in which it is floated, and, after one or two washings, is fit for use by the natives for cakes and soups. The sago intended for export is mixed into a paste with water, and rubbed thoroughly through sieves into small grains.

Sago is a demineralized product and has no more nutritive value than white flour products.

FUNGI and ALGAE

Edible Fungi may be divided into mushrooms *(agaricus campestris),* morels *(morchella esculenta)* and truffles *(tuber libarium)* to which may be added the lichens, of which the most important is Iceland moss *(cetraria islandica),* and algae *(fucus,*

alva, etc.), which are plants of a very simple structure, living in water or upon moist surfaces, including agar-agar and Irish moss *(fucus crispus)*.

The general composition of the various fungi shows that they have not a high nutritive value. The average amount of protein they contain is 3.5 per cent. The mineral matter consists mostly of phosphoric acid and potash, and in the case of truffles, an appreciable amount of soda. They may be eaten occasionally for their flavor. The recognition of poisonous fungi is a matter of great importance. They have as a rule a cup or sac-like envelope near the base of the stem. Their taste is burning, bitter, astringent, or otherwise disagreeable. Their color, with a few exceptions, is red, pink or orange. They generally grow in decaying wood and vegetation. In order to determine the character of the fungi, cooks often use a silver fork or spoon, as the metal is not affected by edible fungi, while it turns black if brought into contact, while cooking, with the poisonous varieties.

The commercial cultivation of mushrooms has also been developed in France, England and later in the United States, and this will gradually diminish the danger of eating poisonous varieties.

ICELAND MOSS is the most important of the edible lichens. It grows abundantly in the Arctic regions, where it serves as an important food for the Laplanders and their reindeer. The bitter principle of the moss is removed to some extent by washing it in water, or in a weak alkali solution. Jellies are made from it by boiling it in water, or milk, with sugar or honey. A five per cent decoction will gelatinize on cooling. Considering the fact that in the inclement climate where Iceland moss grows most abundantly it serves as one of the principal food materials for the reindeer, upon which the natives to a large extent depend for milk and meat, it must have an appreciable nutritive value. Chemical analyses give the following composition of Iceland moss, partially dried:

Water	25.0	per cent
Protein	3 to 6.0	" "
Fat	1.2	" "
Carbohydrates	60.0	" "
Fiber	5.3	" "
Mineral matter	2.2	" "

The carbohydrates are in the form of lichenin, or moss-starch, which is not deposited in granules, as in the cereals and root, but is

uniformly distributed throughout the cells. Like ordinary starch, it is readily converted into dextrose and maltose. No special analysis has been made of the mineral matter. ALGAE includes several varieties of seaweed used as food for men and animals. The most important of these plants is *Irish moss,* or carrageen, which is very abundant on rocky shores, especially those of Ireland, and grows from three quarter tide to below low water mark. Another seaweed, known as dulse or dillisk, is found in Scotland and Ireland. If eaten raw, unwashed, the flavor is brought out by thorough mastication. The weeds are often prepared in various ways and, combined with oatmeal, are sometimes made into cakes. According to Church, the composition of dried moss is as follows:

Water	18.8	per	cent
Nitrogenous matter	9.4	"	"
Carbohydrates, etc.	55.4	"	"
Mineral matter	14.2	"	"
Cellulose	2.2	"	"

The carbohydrates are made up chiefly of a starchy substance called carrageenin, resembling the lichenin of Iceland moss.

AGAR-AGAR, known also under the name of Japanese gelatin, or seagrass, occurs in thin, transparent strips of the thickness of straw, which dissolve almost entirely in hot water, forming a gelatinous, tasteless and odorless jelly. It consists chiefly of a carbohydrate, called gelose, which is insoluble in cold water or alcohol, but soluble in hot water, one part in 500 forming a jelly on cooling. Dried agar-agar in granular form is recommended for the relief of constipation, because of its mechanical action on the bowels, through the expansion of the cellulose.

The "edible birds' nests" which are highly valued as a delicacy in China are made of gelatinous seaweeds. They are eaten and disgorged by the swallows and then used in the construction of their nests. They are generally utilized in the preparation of soups.

CHAPTER V

Cereals, Legumes and Miscellaneous Food Products

The cereals used for human consumption belong to the grass family, and are the seeds of the matured plants in which nature has stored the elements for the germination and growth of the embryo, such as gluten, fat, starch, organic salts and vitamins. The primary object of nature in developing the seed is evidently to provide sufficient organized food material, readily assimilable by the future plant, until its roots, stems and leaves have grown strong enough to absorb nourishment directly from the soil and air.

Although it is evident that cereals were cultivated as staple foods for man before the dawn of recorded history, yet in the light of modern physiological chemistry they do not deserve the term "staff of life," which is often accorded them, for the reason that even if eaten in their natural state, man cannot for an indefinite length of time live exclusively on cereals and retain the best of health.

All cereals have a tendency to acidify the blood, since they carry a large amount of protein, carbohydrates and phosphoric acid. These compounds act as a natural stimulus for the embryo plant, but are detrimental to man if taken to excess. This condition is naturally intensified in artificially prepared cereals that have been robbed of the larger portion of their alkaline content. This point cannot be too strongly emphasized, because at present cereals form the larger portion of man's food supply. Cereals, even in their natural state, are deficient in lime, soda and chlorine, and therefore they do not supply enough of the elements for building sound and healthy teeth and bones. Wherever cereals are used as staple foods, they should always be supplemented by a liberal amount of green leaf vegetables, to supply the necessary alkaline elements.

The principal cereals cultivated are wheat, corn, oats, barley, rye, rice, and to a smaller extent, buckwheat, millet, sorghum and flaxseed.

Wheat, oats, barley, and rye are chiefly grown in temperate zones, while corn and rice are more extensively grown in tropical and sub-tropical countries. Rice is the staple food for the teeming millions of southeastern Asia. The following table gives an idea of the immense production of cereals in the United States, and throughout the world:

Production of Cereals in the United States in 1920

	Acres	Bushels
Corn	106,000,000	3,232,367,000
Oats	41,032,000	1,444,362,000
Winter Wheat	34,165,000	532,641,000
Spring Wheat	19,487,000	218,007,000
Barley	7,437,000	191,387,000
Rye	5,470,000	77,893,000
Grain Sorghums	4,000,000	150,000,000
Rice	1,200,000	42,000,000
Buckwheat	750,000	13,789,000
Total	219,541,000	5,902,446,000

World's Production of the Principal Cereals
(Approximate Figures in Millions of Bushels)

Rice	4,200
Corn	4,000
Wheat	3,000
Oats	3,000
Barley	1,200
Rye	600
Total	16,000 million bushels

The wheat of the world in 1922 was produced chiefly by the following countries:

Country	Bushels	Percentage of Total Production
United States	810,000,000	26.8
Canada	389,000,000	12.9
India	366,000,000	12.0
France	235,000,000	7.8
Argentina	181,000,000	6.0
Italy	162,000,000	5.3
Australia	132,000,000	4.3
Spain	126,000,000	4.1
Roumania	77,000,000	2.5
Germany	70,000,000	2.3
All Others	464,000,000	16.0
Total	3,012,000,000	100.0

Of the total amount of cereals produced in the United States, nearly 6,000 million bushels, the American people eat about 550 million bushels, and 200 million bushels of other grains, while 350 million bushels are exported. The remainder—about 4,800 million bushels, or 80 per cent—is mostly used for stock feed, to be converted into milk and meat.

The average per capita consumption of cereals by the American people is about 350 pounds, or about one pound per day for each man, woman and child. The reasons for this enormous consumption are primarily because of the cheapness of the cereals, and the comparative ease with which they can be harvested, shipped and stored, especially by the aid of modern machinery.

The cultivation of cereals very likely began when man led a more or less nomadic existence, to which the raising of the annual grains was better suited than the planting of trees. In addition, the grains furnished him food for his dray animals. During the course of centuries the various cereals have gradually assumed a leading place in the human dietary. When man, however, comes to realize the tremendous advantage that scientific and intensive horticulture has over the cultivation of the annual grasses, he will resort more and more to tree culture, wherever soil and climate are suitable. With the increasing knowledge of scientific plant breeding, fruit and nut culture will gradually expand into even the northern and mountainous countries.

The chemical composition of the principal cereals is similar in water content, which on an average is about 13 per cent; and also in starch or carbohydrates, which range from 55 per cent in buckwheat to 71 per cent in rye. The greatest relative differences are shown in the amount of fat, which is lowest in rice, about 0.5 per cent, and in the amount of protein, which again is lowest in rice, about 7 per cent, and highest in some of the Russian and Siberian wheats, in which the protein content often reaches 17 per cent. The mineral matter varies from less than 1 per cent in rice to over 3 per cent in oats.

While it has been shown that cereals do not constitute an ideal food for man, it is to be deprecated that his foolish attempts to improve upon nature reduce their value to an appreciable degree. Modern milling processes remove from 50 to 75 per cent of the organic salts, while poisonous gases are often employed in order to

produce snow white flours. Considering the enormous consumption of cereals and cereal products throughout the world, these wasteful methods are most tragic in their ultimate effect upon the health and vitality of people whose diet consists largely of devitalized foods, such as white flour products, degerminated corn meal, polished rice, etc.

A large number of children's diseases, such as adenoids, swollen tonsils, caries, rickets, and in later years, osteo-malacia, pellagra and beri-beri are the result of the continuous consumption of demineralized starchy foods, and lack of fresh fruits and vegetables.

WHEAT

Wheat *(triticum sativum)*, the great staple food of the Caucasian race, is usually grown in all regions where the annual rainfall is less than thirty inches. In fact, some wheat is grown where the rainfall is annually less than ten inches. Frequent summer rains are not favorable to wheat growing, and the warm regions of heavy summer precipitation preclude its cultivation. The ideal wheat climate is found in countries of rainy winters and dry summers which prevail in most regions facing the Mediterranean Sea, some parts of Persia, India, Siberia and America. Wheat lands also border the cooler edges of the deserts of South Africa and Australia. New Zealand has an average wheat yield of thirty bushels per acre, in contrast to the ten or twelve bushels of southern Australia. In South America the principal wheat growing country is the Argentine Republic. The most important wheat growing belt of North America reaches from Texas north through Oklahoma, Kansas, Nebraska, the Dakotas and Minnesota into Canada. The Pacific Coast States have excellent wheat yields in portions that have sufficient rainfall during the winter. Parts of California at one time developed an important winter wheat crop, which continued throughout several decades following settlement by Americans. In fact, the wheat crops of the great valleys of California were once world famous, but now they have been largely superseded by more profitable orchard products.

In the northern portion of the Mississippi Valley, above 45 degrees latitude, the winters are too cold for fall-sown or winter wheat, especially as there is no heavy snowfall to cover the ground

for protection against heavy frosts; but the equally distributed rainfall from March to June permits the planting of wheat in the spring, and promotes the grassy growth of the spring wheat which ripens in the later and drier part of the summer.

Europe has a climatic distribution similar to that of the United States. Near the Atlantic where the climate is mild and the precipitation abundant, winter wheat prevails. In the drier interior countries that have summer rains, spring wheat is grown. The great spring wheat belt of the Eastern Hemisphere begins in Roumania and stretches through Southern Russia, northeastward across the basin of the Volga to the Ural mountains, and beyond them across Siberia to the rough mountainous country east of Lake Baikal. Southeastern Russia, north of the Caucasus and East of the Caspian Sea, again, has a winter wheat belt.

The winter wheat varieties of western Europe and of eastern United States and California are starchy and soft. The spring wheat of central North America, especially the *Durum* and *Red Fyfe,* is so hard and brittle that the outer layers of the kernel break into little particles, so that for many years, and until steel roller milling was perfected, the flour had a mixture of brown bran particles and was therefore yellowish in color. This flour was not popular, on account of the preference of the ignorant consumer for snow white, or bleached flours. Few people realize that at present wheat flour is extensively bleached simply for the purpose of making more attractive and salable articles, regardless of its lessened nutritive value. By bleaching, a greater percentage of the flour produced can be rated as being of first quality, which means, naturally, superfine, or "snowwhite." Ozone and oxides of nitrogen developed by electrical discharges are the principal bleaching agents employed. Bleached flours should be labeled as such.

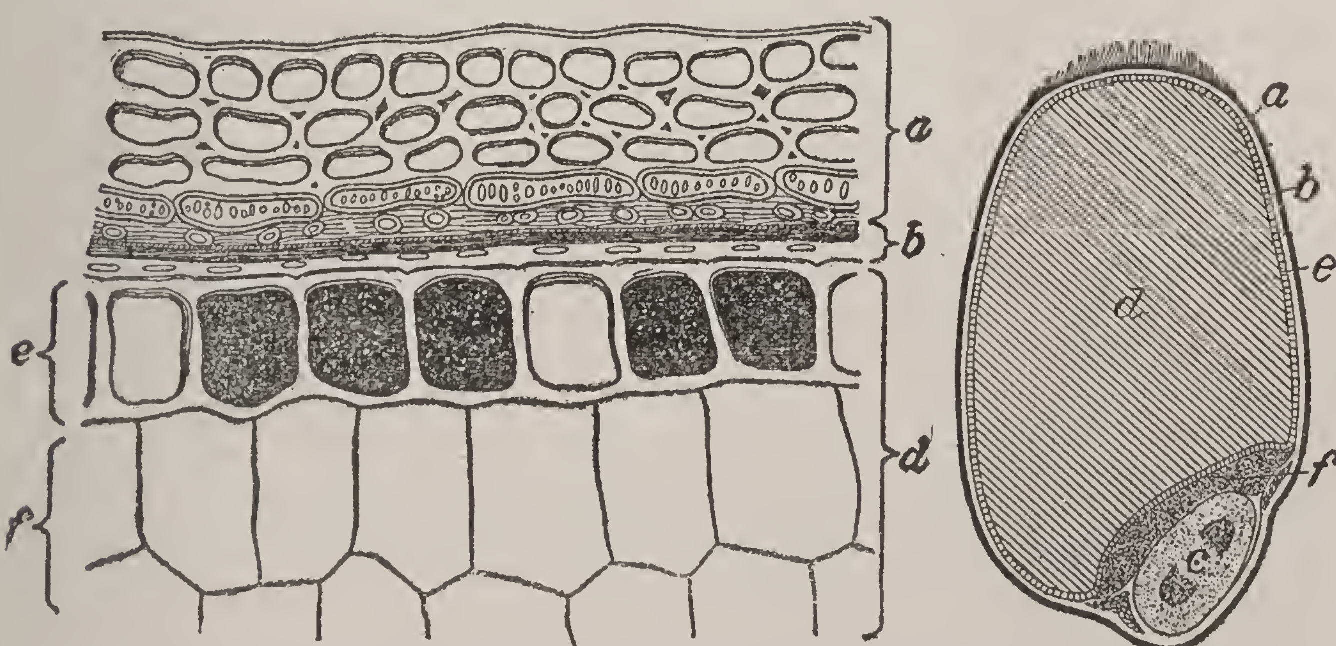
Winter wheats are poorer in gluten and richer in starch than spring wheats, which often show gluten contents of 16 per cent, and are, therefore, valued in the manufacture of macaroni and semolina. There is also a difference in the chemical composition of mineral matter of winter and spring wheat. A large number of analyses have been made by Dr. E. Wolff, a German chemist.

The average percentages of winter and spring wheat are given in the following table:

	Winter Wheat	Spring Wheat
Potash	31.16 per cent	30.51 per cent.
Soda	3.07 " "	1.74 " "
Lime	3.25 " "	2.82 " "
Magnesia	12.06 " "	11.96 " "
Iron	1.28 " "	0.51 " "
Phosphoric Acid	47.22 " "	48.94 " "
Silica	1.96 " "	1.46 " "
Sulphuric Acid	0.39 " "	1.32 " "
Chlorine	0.32 " "	0.47 " "

The mineral matter of both varieties is almost entirely composed of phosphate of potash and phosphate of magnesia with very small proportions of soda, chlorine, and lime. It always shows a decidedly acid reaction.

About seventy per cent of the phosphates and iron are contained in the outer layers and germ of the kernel; and in these parts are also found the vitamins. The following diagrams, very much enlarged, show the cellular construction of a wheat kernel, which is typical for all cereals:



(Courtesy U. S. Department of Agriculture)

"A" is the bran coat, rich in silica, lime and iron; "b" is composed of several protective layers, containing a ceraline substance, most of the phosphates and other organic salts; "c" is the germ; "d" the white interior, consists chiefly of starch grains mixed with gluten (see illustration in Chapter 8); "e" and "f" con-

tain the gluten cells, fat and organic salts, deposited by nature as food material for the first stages of germination.

By modern milling processes the important blood and bone building elements, calcium, magnesium, iron, silicon, and fluorine, are largely removed, as shown in the following table:

	Total Salts	Potassium (K_2O)	Sodium (Na_2O)	Calcium (CaO)	Magnesium (MgO)	Iron (Fe_2O_3)	Phosphorus (P_2O_5)	Sulphur (SO_3)	Silicon (SiO_2)	Chlorine (Cl)
Whole Wheat	23.10	7.20	0.50	0.75	2.80	0.30	10.90	0.09	0.46	0.07
White Flour	5.70	1.82	0.08	0.43	0.44	0.03	2.80	.....	.....	.....
Rye, whole grain	21.30	6.84	0.31	0.61	2.39	0.25	10.16	0.28	0.30	0.01
Barley, whole grain	31.30	5.10	1.28	0.02	3.92	0.53	10.27	0.93	8.98	.....
Oats, whole grain	34.50	6.18	0.59	1.24	2.45	0.41	8.83	0.62	13.52	0.03
Corn, whole grain	18.50	5.50	0.02	0.04	2.87	0.15	8.44	0.15	0.39	0.35
Corn, degerminated	6.85	2.07	0.24	0.43	1.02	0.10	3.08	.....	.....	.....
Whole Rice	16.00	3.60	0.67	0.59	1.78	0.22	8.60	0.08	0.42	0.02
Rice, polished	4.00	0.87	0.22	0.13	0.45	0.05	2.15	0.03	0.11	0.01

The supposed benefit derived from gluten flour, often recommended in cases of diabetes, is a delusion, as in the manufacturing process nearly all the alkaline elements are washed out, leaving a product that is detrimental rather than beneficial. Diabetes indicates high acidity of the blood, which is unable to oxidize the carbohydrates in food and, therefore, requires as a remedy a diet rich in alkaline elements.

Other wheat products, such as macaroni, spaghetti, noodles, etc., although rich in gluten, are lacking in organic salts, and should be used sparingly and always combined with foods rich in these elements.

Well baked bread or crackers, made from finely ground, entire grains, requiring thorough mastication, are by all means preferable to the many artificial bakery products and widely advertised breakfast foods.

Recently a process has been developed in Europe, by which bread can be made directly from wheat. The method, which is termed the Pointe Navarre system, was perfected by a French engineer named Navarre. This system consists of three stages of operation. The first of these is washing the wheat with quantities of running water, thus freeing the grain from dust and other impurities much more thoroughly than by the dry cleansing com-

monly employed by the mills. After washing, the wheat is soaked in pure warm water of 95 degrees F. in which one per cent of sea salt has been dissolved. This process continues for fifteen to twenty hours, according to the hardness of the grain. At the end of this time the latter has absorbed an amount of water equal to two thirds of its original weight.

The grain is now ready for the third stage of operation which consists in passing it through an apparatus devised by Navarre. The machine is operated on a principle similar to that of the mechanical colanders or pulpers employed by modern canning companies in making preserves or jams, in order to separate the pulp of the fruit from the skin, tips and seeds. The apparatus consists of a horizontal separator, pierced with small holes like an ordinary kitchen colander and lined inside with fine meshed wire cloth. Inside this are revolving cylinders alternating with movable strips of iron. The humidified grain is fed into the machine by a funnel at one side and is pressed between the sieve and the cylinders and thus crushed against the wire cloth. The pulp thus produced passes through the drum and is scraped off by a stationary knife, falling into a vessel beneath the mechanism while the bran, which is carried forward by the cylinders and the strips of iron, drops into another receptacle. The pulp or paste is then worked into a dough in the usual manner. The bran is made into cakes for fodder, while still damp, or dried in an oven and employed in the same manner as bran obtained from the milling of grain. It seems that by soaking the wheat for twenty-four hours most of the organic salts and vitamins pass into the dough, so that little nutritive value is left in the bran.

It is stated that the bread produced from this material is of excellent flavor, while a saving of about 20 per cent of the grain is achieved. By the old methods of milling, 100 pounds of wheat yield only 70 pounds of flour, from which 94 pounds of bread are produced, while by the Pointe Navarre process 100 pounds of wheat produce from 110 to 120 pounds of bread. Moreover, the bread produced by this process is far more nourishing and likewise more easily digested than bread made from white flour. There is no doubt that an excellent unleavened bread can also be made from the wheat paste, especially with the addition of some nut butter or

vegetable oil. This process certainly has many advantages over the usual methods of bread-making.

RYE

Rye *(secale cereale)*, contains considerably less gluten than wheat but is richer in silicon and fluorine, which are important in the formation of the enamel of the teeth. For this reason in all countries where chiefly whole rye bread is eaten, dentists are conspicuous by their absence. Rye is a product of the northern temperate zone and will thrive in many soils and climates where wheat will not grow so well. It will endure cold winters, wet, sandy and poor soils, and will even thrive in rough and hilly countries.

Rye is only grown to a small extent in the United States. The chief rye producing districts are eastern New York and Pennsylvania, Michigan, Wisconsin and Minnesota. In Germany, Austria and Russia are grown the chief breadstuffs of the poorer classes, Russia producing more than half of the world's rye crop, while Germany produces more than one-fourth.

An excellent health bread can be made by mixing equal parts of whole wheat and rye flour. The so-called Swedish "Ry-Krisp" is a most palatable and wholesome cereal product which has become quite popular in the United States.

BARLEY

Barley *(hordeum vulgare)* is the hardiest of the cereals. It can be grown in semi-arid, sub-tropical countries, as well as in far northern countries. Like rye, it has less gluten than wheat, and is therefore not so well suited for bread-making. It has a short growing season and is especially adapted to the Antarctic summers. Barley does well even in northern Scandinavia and in Lapland, ripening there at 70 degrees latitude, beyond the Arctic circle. On the other hand, it is grown as far south as Egypt and Abyssinia, and was one of the staple foods of the ancient Hebrews, Greeks, and Romans. It constitutes an important crop in Spain and Algeria. In Germany and Britain it is almost equal in importance to wheat.

California, with annual crops of forty million bushels, is the leading barley territory in the United States. Barley is also grown on the high plateaus of the Rocky Mountains. It is cultivated to

a large extent in the Dakotas, Minnesota and eastern Wisconsin, where it is mostly used for making "near-beer" by Milwaukee breweries. The average yield of barley in the United States is 26 bushels per acre, exceeding that of both wheat and rye.

While a great deal of barley is used for stock feed, it is extensively used as a human food, mostly in the shape of pearled barley, which is another demineralized food. A wholesome flour may be made from the plain hulled barley and used for baking purposes in combination with whole wheat and rye flour. Coarse ground unpearled barley meal is largely used as "porridge" in Scotland.

OATS

Oats *(avena sativa)* is the cereal richest in fat and organic salts, while the gluten content is about equal to that of rye and barley. Like the latter, it requires a shorter growing season, and for that reason can be grown further north than spring wheat.

The oat grain has a thick, close fitting husk, which has to be removed by special machinery, if the grain is utilized for human food. Oat meal and flaked oats are the chief manufactured products, and as they contain the larger portion of the mineral salts, they are the least objectionable of all cereal foods sold in the markets. The United States and Russia are the largest producers of oats, while Germany takes third place. As a food, it is best adapted to the inhabitants of cool countries, just as rice is a suitable food for the tropical and sub-tropical regions.

BUCKWHEAT

Buckwheat *(fagopyrum esculentum)* is the least important of the cereals, and is cultivated only in the eastern portions of the United States and northwest Europe. It is also grown in the mountainous districts of Japan, where it displaces rice. It is a summer cereal and can thrive on poorer and rougher land than wheat. It is generally placed upon the market for making the well-known buckwheat cakes. There is probably no bread or cake-making material that is subjected to more extensive adulteration than buckwheat flour, most of that which is sold under the name being merely imitations of that substance. Mixtures of rye flour, Indian corn flour, wheat flour, and other ground cereals are used as a substitute for buckwheat. From a hygienic point of view there is no objection

to the flours substituted, but the use of these mixtures under the name of buckwheat can be regarded in no other light than as an unpardonable fraud.

CORN

Corn, maize or Indian corn *(zea mays)*, constitutes the leading cereal crop of the United States today. It is a native of the American continent, and was extensively used by the Indians when the first American settlers landed at Plymouth Rock. Corn shows less protein than wheat, but nearly equals oats in the amount of fat, which is mostly contained in the germ.

Corn requires a long and moist summer and will fully mature, if the weather conditions are favorable. The annual yield depends much upon the rainfall and irrigation, and varies from 30 to 38 bushels per acre.

The United States produces about three-quarters of the world's corn crop. The leading corn growing states, composing the so-called corn belt, are Illinois and Iowa, with over eleven million acres each; Kansas and Nebraska, with over nine million acres each; and Missouri with over seven million acres. Next to cotton, corn is the most important crop of the Gulf States. It is also grown to a lesser extent in the Atlantic Coast States, as far north as New York.

A very small percentage of the corn grown in the Mississippi Valley goes directly to the market as grain. In all of the Central States by far the larger portion of the corn crop is fed to farm animals; and it is often preserved for this purpose in silos, while in Illinois nearly half of the corn crop is shipped out of the state. Over fifty million bushels of corn are shipped to mills for the manufacture of corn starch and corn starch syrup, known as the glucose of commerce, and used extensively in the manufacture of candies, as well as in the preservation of food products. Under special names glucose is also used as a table syrup. It is made by means of diluted acids from corn starch, and, needless to say, its use cannot be recommended as it is a denatured and demineralized product. The annual consumption of glucose in the United States is over 500,000,000 pounds, chiefly manufactured in Illinois and Iowa.

An oil is pressed from the germ of the corn, known as corn oil or maize oil, and is refined under high steam pressure to remove

the raw, disagreeable taste. This oil is, therefore, not as wholesome as the cold pressed peanut or olive oil.

From one to two hundred million bushels of corn are annually shipped from the American corn belt to northwestern Europe, where they are used for stock feed. Although during the World War efforts were made to introduce corn in various forms as human staple food, the consumption in Europe is still very small. It is an unimportant crop in southeastern Europe, in the countries bordering on the Black Sea, but is raised only for home consumption, chiefly for cattle feed.

Corn is the leading cereal in nearly all the Latin American countries, from Mexico down to Argentina. *Tortillas,* the corn cakes of the Mexican, combined with *frijoles* and a few vegetables constitute the principal diet of the poorer classes throughout Mexico and Central America. The Mexican always uses the whole corn, whereas the corn meal sold in the U. S. is, as a rule, degerminated and devitalized. The same deficiencies exist in the *polenta* of the Italians. The hookworm disease of the Southern States and pelagra in Europe are the result of a diet consisting largely of such impoverished corn, deficient in lime, magnesia, iron and silicon, and are not caused by a specific germ. Corn flour, if made from the entire corn, is a wholesome food, and in combination with alkaline vegetables makes a well-balanced meal. During the summer season, when the corn is young, and the carbohydrates in soluble form, it may be eaten without further preparation.

Hominy, which is corn thoroughly boiled after the outer layer has been removed by means of a weak lye solution, is a demineralized food.

Popcorn, made by breaking open the cells of a special kind of corn and dextrinizing the starch over a slow fire, is preferable to many artificial corn preparations.

MILLET

Millet, or grain sorghum *(sorghum vulgare),* produces small, round seeds, resembling corn in chemical composition. They contain on an average:

Water	11.0 per cent	Carbohydrates	72.5 per cent
Protein	9.0 " "	Crude fiber	2.0 " "
Fat	3.5 " "	Mineral matter	2.0 " "

The grain sorghums comprise three varieties: the *Durras,* including *Dwarf* and *White milo*; the *Kafirs,* and the *Kaolings.* Many varieties of these corn substitutes have been grown for ages in the Eastern Hemisphere. Some varieties have been selected to produce grain for both men and animals, while others have been specialized to produce stalks for feeding animals only.

Millet is grown mostly for forage in the Mediterranean region and western Russia, but is also used there to a small extent for human consumption. As a cereal staple food for man, it is of greatest importance in eastern Russia and China.

It is estimated that one-third of the human race includes the small millet in its daily diet, and records in China show that millet has been cultivated for over five thousand years. In India the consumption of millet is greater than that of wheat; it often supplements rice in Japan, while it is grown for forage only in nearly all parts of the United States.

The first introduction of grain sorghums into the United States occurred in 1874 when they were brought from Egypt to California, where they do well, as they can withstand more drought than most other field crops grown. Dwarf millet is the best variety for grain, while for forage purposes the Kafir, because of its juicy stems, is preferable. In the Imperial Valley, in Southern California, 150,000 acres of milo maize were cultivated in 1918.

The grains of the sorghum more nearly resemble buckwheat flour in flavor than either corn or wheat. If the grains are used unpolished, they are wholesome and nutritious, and their flavor is usually regarded as agreeable. They have served as a staple food in southern Egypt for many centuries. The average yield of grains per acre in the United States is nearly one ton.

Sweet Sorghum is now used extensively for making sorghum syrup, which is more wholesome than corn starch syrup, especially if it is concentrated at a low temperature in vacuum pans. One acre of sorghum will yield about twelve tons of stripped cane, which will make 132 gallons of syrup that can be used as a substitute for sugar in baking and canning.

RICE

Rice *(oryza sativa)* is the most important and most productive food cereal in the Orient, where it has been cultivated since time immemorial, and where still 97 per cent of the world's rice crop

is produced. According to historians, a ceremonial ordinance was established in China by the Emperor Chinung, 2,800 B. C., in accordance with which the emperor sowed rice himself while the seeds of four other cereals might be sowed by the princes of his family. In some parts of the Orient, where it is grown in large quantities, rice was, and is still, a medium of exchange. Moreover, necessity has taught the people in these densely populated countries to use every part of the rice plant. Rice straw is used in China and Japan for making paper, matting, sandals, brooms, hats, and many other useful articles.

Rice was not known to the ancient Greeks and Romans. It was introduced into Europe by the Arabs in the fifteenth century. It was first cultivated in the Valley of the Po, near Pisa, while in America cultivation was begun in Colonial days. It has now achieved commercial importance in the Carolinas, Georgia, Louisiana, Texas, Arkansas and the Sacramento Valley in California. The emigration of East Indian laborers has introduced rice growing in Jamaica, Trinidad, Honduras and Guiana.

Rice is distinctly a cereal of tropical and sub-tropical countries with their wet summers, or of places having plenty of water for irrigation, as in the valleys of the Sacramento in California, and the Po, in northern Italy. The countries, however, with frequent warm summer rains are the principal rice growing territories of the world. Southeastern China has probably the largest rice growing districts, followed by the lower Ganges Valley and its adjoining territory, with its wide stretches of alluvial soil and nearly one hundred inches of summer rains. Other rice areas of southeastern Asia are the deltas of the Irawadi in Burmah, the Menam in Siam, and the Mekong in Cochin-China. The cities of Bangkok, Rangoon and Saigon are the greatest rice ports of the world, where in the mills of English, French, and Chinese firms the paddy, or rough grain, is cleaned in the wasteful manner demanded by European and American consumers. Japan has more than half of all her arable lands laid out in rice fields, with a per capita consumption of 170 pounds annually. Japan has lately been importing rice from California.

The varieties of rice grown in the United States are the *Carolina Gold* and *White,* best adapted to the Atlantic coast; the *Honduras,* and several Japanese types of rice, to the Gulf States; and the

Japanese types only, to California. The Japanese varieties with their short round kernels are preferred because they can be milled at less cost.

California has the most remarkable rice growing area in the United States. The acreage in the Sacramento Valley has now increased to over 80,000 acres, with an astonishing yield of seventy bushels per acre, as compared with 36 bushels per acre in Louisiana.

In harvesting the rice, it is first threshed to separate the straw from the paddy, which must be milled before it can be used as a food. The paddy consists of a tough fibrous hull and a bran coat, inside of which are the germ and the main part of the grain, known as the "endosperm." The primitive manner of milling rice was to pound it by hand in a stone or wooden mortar with a pestle until the husk and cuticle cracked, rubbed off and could be winnowed out. Machinery has now for the most part displaced the old hand way of cleaning, but in this country still more elaborate methods are used. The rough rice is first screened and fanned to remove particles of dust, straw and other foreign matter, and then passed between milling stones set sufficiently close together to break the hulls, without crushing the grains. The light chaff is blown out by fans, and a device, known as the paddy machine, sorts out the grains that were not hulled the first time, so that they can be transferred to another set of stones adjusted to hull the smaller grains.

This first milling produces the unpolished or brown rice, containing the germ and the outer layers of the kernel, which is now in the very best state to be used as food. But in order to satisfy the perverted taste of a people that commercialism has educated to sacrifice quality for attractiveness, the rice is put through a series of machines that scour, polish and in some cases coat it with glucose and talc. As in the case of white flour, peeled and polished rice has lost its vitamins and the greater portion of the organic salts, like lime, magnesia, iron and silica, and its continuous use causes beri-beri and similar diseases of the nervous system.

Pellagra and hookworm diseases, following a corn diet, find their counterpart in the beri-beri diseases of the Orient, where peeled rice has displaced the natural brown rice as a staple food. In all Oriental ports where American and European methods of rice milling have devitalized this cereal, nutrition diseases are on

the increase. The death rate in Manila due to beri-beri for children under one year of age is 430 per 1000. Professor Philip Andrews who recently published a number of articles on this subject in the "Science Magazine," found that an autopsy on 219 infants under one year old who had been diagnosed by physicians as having died from acute meningitis, congenital debility, convulsions, acute bronchitis, or enteritis, showed that 126 or 56.6 per cent actually died of a condition which Andrews called beri-beri. These infants appeared to be well-nourished to the superficial diagnostician, but they had symptoms that this authority described as characteristic beri-beri, i. e., labored breathing, high pulse rate, etc.

As children one year old are seldom fed on polished rice, Andrews accounted for these deplorable conditions by the fact that in most cases the mothers reveal symptoms of beri-beri; and that their diet is usually white rice and fish, or meat, and rarely vegetables or fruit. While polished rice is deficient in vitamin "B", the fundamental cause of beri-beri is mineral starvation, and not the lack of protein, as has often been assumed. The remedy is natural brown rice with plenty of green leaf vegetables and fresh fruits, to supply an abundance of alkaline salts.

WILD RICE

In various parts of the North American continent, especially the northern Mississippi Valley and southern Canada, a water plant generally known as wild rice *(zizania aquatica)* and often as Indian or Canadian rice is frequently found along the edges of small lakes and streams. It is not true rice, but belongs to a different botanical group, although it resembles rice in nutritive value. At one time this wild rice was one of the staple foods of the Indians, ranking next to corn. The grains of wild rice are longer and less rounded than those of the true rice, and the husk is dark brown in color. The Indian women parch the rice in kettles over an open fire, as the heat not only improves the flavor and keeping qualities of the grain, but also makes the rough husk easier to remove. Recently, the harvesting of wild rice has been undertaken in a commercial way, especially in northern Minnesota, and machinery is being developed to replace the crude Indian method of threshing.

SUGAR CANE

Sugar cane *(saccharum officinarum)* is a species of grass which was probably first cultivated in southeastern Asia, but is now grown in large quantities in all tropical countries. Of the Western Hemisphere, the West Indies, Hawaii, and Brazil are now the principal sugar cane countries. It is used by the natives in its natural state as a staple food. Its sweet acidulous juice, which is released by thorough mastication, is very nourishing. Native children are especially fond of the sweet, ripe cane. Judging from the splendid condition of their teeth, and their sleek, well-proportioned bodies, the natural juice of the cane must contain the blood and bone building elements that are lacking in the refined sugar of commerce.

Sugar cane is propagated by slips taken from the upper part of the canes, which are planted at intervals of five feet apart. As the joints ripen, the leaves wither and fall away, and the stem becomes externally smooth and hard, containing much silica. The stalks, or canes of the plant, reach a height of from eight to fifteen feet, and attain a diameter of 1½ to two inches. The average composition of the four most common varieties is as follows:

Water	71.0 per cent
Protein	1.0 " "
Sugar	18.0 " "
Pectin and woody fiber	9.5 " "
Mineral matter	0.5 " "

As soon as the cane is ripe the stalks are cut close to the ground, then removed to the crushing machines, which extract the juice. In order to clarify the liquid, bi-sulphate of lime is added, liberating sulphurous acid, which coagulates the albumen. The latter gradually settles at the bottom of the vessel, taking along small particles of cellulose particles floating in the juice, which is then drawn off and boiled down over a direct fire. The scum of the boiling juice is collected and distilled into rum, and the remaining condensed liquid removed into shallow coolers. The sugary crystals that soon form, constitute the muscovada or raw sugar, while the remaining heavy dark brown liquid is the molasses, in which a large proportion of sulphurous acid is retained.

From a hygienic point of view, the refining of sugar is a wasteful process, as it destroys all the organic salts and vitamins

contained in sugar cane. The natives, who prefer to eat the cane in its natural state, are very much benefited by its liberal consumption, as mentioned above. The natural juice of the sugar cane, if condensed in vacuum pans at a low temperature, is the best known method of retaining all its valuable constituents, and in the concentrated form it can be shipped easily and used instead of the devitalized, refined sugar of commerce.

Legumes

Legumes (or pulses) are, next to cereals, the most extensively used plant food. They include one-celled, two-valved seed pods, containing one or more seeds, such as the bean, pea and lentil. The peanut, which also belongs to this class, has been described in Chapter III.

Legumes in their dry state have a very high percentage of protein—over 20 per cent—resembling in this respect the nuts; from 1.5 to 16 per cent fat; and from 50 to 60 per cent of carbohydrates, mostly starch. The composition of the mineral matter resembles that of cereals, showing a large amount of phosphate of potash and magnesia. Legumes are, therefore, decidedly acid-forming—in fact, in their ripened seeds are stored small amounts of purin bodies.

Beans and peas are especially valuable, and they may be used at different stages of their growth: (1) as tender pods (string beans and sugar peas) which can be gathered when the seeds are less than half grown—in this form, if eaten with the pods, they have an alkaline reaction, as they contain more lime and less phosphoric acid; (2) as the nearly grown, but unripened shell beans and green peas; (3) as fully ripened seeds—dried beans, peas and lentils; and (4), as flours made from the perfectly dried seeds.

A distinguishing feature of the legumes and a contributing factor in the support of plant life is their ability to produce upon their roots nodules that contain colonies of nitrogen gathering bacteria. These small organisms take up nitrogen freely from the air, and thus enable the legumes, upon which they live, to store it up, especially in their seeds. By the aid of these bacteria, the legumes can grow in poor soil and enrich it with nitrogen, because of the nodules on the roots which remain in the ground after the harvesting of the crop.

Experiments have demonstrated that in mixed stands of legumes

and other plants the latter are richer in nitrogen because they are supplied with that element by coming in contact with legumes.

Perhaps no single agricultural crop is of greater importance in this respect than cow-peas, which are rapidly growing in favor in this country as a most valuable forage crop, and a great soil renovator. The seeds are valuable as grain; the hay is equaled only by alfalfa, and as a producer of organic matter for green manure, it is unsurpassed.

The Americans, being heavy meat eaters, use far less of the legumes than do the inhabitants of Europe, especially those of the Mediterranean countries. In China and Japan the soy bean has been an important article of diet for many thousands of years. With the Bedouins and other Asiatic people the porridge of lentils has been in constant use since ancient times. The birthright that Esau sold to Jacob for a "mess of pottage" is supposed to have been made of lentils. A Hindoo proverb says: "Rice is good, but lentils are my life." The Arabs feed their horses ground beans to prepare them for extraordinary exertion.

BEANS

Under the general term "bean" *(faba vulgaris)* we include a large variety of closely related plants, such as the lima, pink, the bayo, cranberry, Lady Washington and the small white (navy), natives of South America; the black eye, garbanzo (chick-pea or gram), the horse bean, from the Orient; the white tepary and red Mexican, natives of Mexico; the blue pod bean, originated in Lompoc Valley, California; and the red kidney bean, first cultivated in the Eastern States.

There are about one million acres devoted to bean culture in the United States. Three states—Michigan, California, and New York—are leading all others. In 1917, California had planted 538,000 acres to beans, producing 15,701,000 bushels.

The garbanzo or chick-pea *(cicer arietinum)* containing over 6 per cent fat, is the leading protein food in Spain and northern Africa. England exports chick-peas especially for making soup, while France, before the war, imported about 35,000 tons from northern India.

As previously mentioned, in eastern Asia the soy bean *(dolichos*

soya) is one of the chief providers of protein and fat, and is second only to rice in importance as a food crop. It contains more than four times as much protein as rice, also 16 per cent fat; it is manufactured into a great variety of products, all having a high percentage of protein.

Soy beans, when about three-fourths grown, make a most palatable and nutritious green vegetable, like the green pea or the lima bean. A vegetable milk is made from the dried beans. They are finely ground into flour, then thoroughly mixed with three parts of water and boiled for half an hour. The milky emulsion obtained is similar in appearance to cow's milk, but naturally of a different chemical composition, especially in mineral elements, as it is lacking in calcium, sodium and chlorine. This soy bean milk is frequently used in making bread, cake, and in creaming vegetables. If left in a warm place it will turn sour like animal milk. In Japan a condensed milk is obtained by evaporating soy bean milk in a vacuum. A cheese is also made there, by adding about one per cent of magnesium or calcium salts to the soy bean milk, which precipitates the proteins into a grayish white curd, leaving a yellowish liquid. The curd after being thoroughly drained and pressed is called "tofu," which forms the basis of numerous unfermented, smoked and dried cheeses in China and Japan. However, these bean cheeses, although nutritious, are lacking in the flavor and palatability of those made from cow's or goat's milk.

Soya sauce is a heavy, dark brown liquid prepared from a mixture of cooked and ground soy beans, roasted and pulverized wheat or barley, salt and water. The mixture is inoculated with a culture known as rice ferment and left in casks to slowly ferment for six months or more. This sauce, which is salty and pungent, not unlike meat extract, is generally used as a condiment for boiled rice or vegetables. The yearly production of soya sauce in Japan alone is nearly two million barrels. It takes the place of salt in the Japanese and Chinese diet and is occasionally used by Americans in the Pacific Coast States. The fat or oil of the soy bean is of excellent flavor and is used for culinary purposes throughout the Orient. It is more easily digested than animal fats and is equal in nutritive value to peanut oil.

PEAS

Peas *(pisum sativum)* are natives of Europe, where they were cultivated long before the dawn of the Christian era. While they are usually grown for their seed, there are several varieties with thick soft green edible pods that may be eaten with the seed. Peas may be classified as climbing; half dwarf, or showing a tendency to climb and doing best when supported; and dwarf peas that require no support. Peas are among the earliest garden vegetables and are grown in endless varieties, often as purely ornamental plants. They are much more hardy than beans and can withstand cold and light frosts.

Sugar Peas, which are comparatively little known in this country, are largely grown in Europe. They are characterized by more or less fleshy and often distorted or dwarfed pods, which may be cooked when in the same state of maturity and in the same manner as string beans.

THE LENTIL

The lentil *(ervum lens),* as previously mentioned, is one of the most ancient of food plants, probably one of the first to be brought under cultivation by man. It has been used in Egypt and in the Mediterranean countries for thousands of years. Until recent years, the lentil was little known in the United States, although small quantities of it have been imported every year. The red lentil comes from Egypt, and the large purplish-green lentils from central Europe. There is grown in New Mexico and Arizona, as well as in Mexico, a small variety of lentil, the seed of which was doubtless brought from Spain centuries ago.

Lentils, flavored with green leaf vegetables, make excellent soups and stews. In addition to phosphate of potash and magnesia, they contain an appreciable amount of sodium, chlorine and iron. Lentils are much richer in iron than any other of the legumes.

The preparation of the legumes, especially in their dry state, is one of great importance in order to insure their digestion and assimilation. They should be cooked in soft or, better still, distilled water, if available. If the water which is used for cooking is hard, due to the presence of calcium carbonate, one teaspoonful of baking-soda per gallon may be added, and then boiled

and cooled before using, in order that the calcium carbonate may precipitate. It is advisable to soak lentils and beans over night in water, in order to soften them. Experiments have demonstrated that the digestibility of legumes is facilitated by using distilled water in cooking; they can be made still more palatable if served in the form of puree by pressing the boiled seeds through a sieve. Flours made from dried peas, beans and lentils are excellent for making soups and purees, but a double boiler should always be employed for this purpose, to prevent scorching. They should always be cooked (simmered) very slowly.

If used moderately and with discrimination, preferably combined with vegetable salads, legumes may be used as a substitute for animal food products without the usual disagreeable symptoms occurring during the process of digestion. If eaten often and to excess, they produce acidity of the blood, on account of their large amount of nitrogenous matter and acid-forming elements. Outdoor workers can digest legumes better than sedentary workers, who should eat them not oftener than once or twice a week.

OILY SEEDS

Flaxseed is the product of the common flax plant *(linum usitatissimum)* which is indigenous to southern Europe and northern Africa, also to some parts of Asia. It is now raised quite extensively in the United States and Canada. While flax is cultivated mostly for the bark and the inner portion of the stem, from which linen thread and cloth are made, the oil seeds yield the drying fluid called "linseed oil." Flaxseed is frequently used for medical purposes as an emollient and demulcent in irritations of the mucous membranes, also as an ingredient of many cereal preparations to give them a slightly laxative effect.

Sesame *(sesamum indicum)* is one of a dozen species of annual hairy herbs, indigenous to Africa and India. Since ancient times it has been cultivated in eastern Asia and many tropical and subtropical countries. The oil obtained from the seeds, sesame oil, resembles olive oil. In the Orient it is mixed with honey and preserved citron and sold as a luxury. In some parts of Africa the seeds are used for making pudding. The leaves of sesame abound in a mucilaginous substance, which readily passes into water, making a rich demulcent drink used in the Southern States. Sesame

oil is not produced in the United States and is imported to some extent by those who have become accustomed to its use in other countries.

Cottonseed, a product of the cotton-plant *(gossypium hirsutum)*, is used extensively for the production of cottonseed-oil in the United States. Cottonseed-oil is usually hydrogenated.

Rape-seed, coming from the rape plant *(brassica napus)*, is manufactured into rape-oil throughout Europe and eastern Asia.

Sunflower seeds are derived from the sunflower *(helianthus annuus)* which is grown largely in Hungary, southern Russia, India and China, for the purpose of making sunflower oil.

The seeds of the poppy *(papaver somniferum)* are also frequently used for the production of table oil. The best grades of these oils are obtained from the first pressings without heating and are preferable to the refined oils.

HONEY

Honey has been used as a food from the earliest times, and constituted one of the principal sweetening materials up to about fifty years ago when sugar became a commercial product and was more or less available for all classes of people. It is still appreciated by those who prefer a natural sweet to refined sugar, or corn syrup. We should bear in mind that honey is manufactured by the bees primarily for the purpose of supplying themselves with food during the winter months, and man often obtains his supply by taking from the bees their natural food and substituting artificial sweets. A liberal supply of honey should always be left for the bees instead of giving them refined sugar, as it is quite probable that the frequently recurring bee diseases that have proved such a menace to bee keeping, are attributable to the fact that a large number of greedy people have forced the busy little workers to depend upon demineralized food.

Bees perform a valuable service in fertilizing flowers and blossoms, and the intelligent orchardist will see to it that he has a few hives of bees in or near his orchard, as they will effect a material increase in the fruit crop.

Prior to the passage of the Federal Pure Food Law, in 1906, strained honey was frequently adulterated with glucose, or cane

syrup, but the practice has since become unsafe and has therefore been almost entirely abandoned.

Honey is a concentrated food and should be used sparingly. It contains about 75 per cent of carbohydrates made up of equal parts of dextrose and levulose; about 2 per cent sucrose; 18 per cent water, and 0.23 per cent of mineral matter. In addition, honey contains a small amount of formic acid.

The flavor of honey is due to volatile bodies in the flowers from which it is obtained, such as the blossoms of orange, sage, clover, alfalfa, thistle, eucalyptus and many others. Honey is often a compound of many different flowers and, therefore, lacks any distinctive flavor.

It was formerly assumed that the composition of honey was practically the same as that of the nectar gathered by the bees, but it has been found that the nectar undergoes certain changes in the honey-sac of the bee and that the chemical properties of the honey are somewhat different from those of the nectar. Almost all pure honey when exposed to light and cold becomes more or less granular in consistency.

Owing to the presence of impurities so generally introduced by the bees, much difficulty is found in attempting to set up a suitable standard of purity for honey as found in commerce. The difficulty is increased by the common practice of artificially feeding bees.

The nectar of flowers contains from 70 to 80 per cent of water, but honey contains only about 20 per cent. The reduction is effected partly by the bees exposing the nectar in thin layers to the action of a current of air produced by the fanning of their wings and partly by a process of regurgitation, the nectar being continually thrown out from the honey-sac on the partially doubled tongue and then drawn in again until, by the movement of the air and the heat of the hive, the nectar is sufficiently concentrated to be deposited in the cells of the comb. Another change of considerable importance, which takes place while the nectar is in the honey-sac of the bee and also probably during evaporation and storage in the comb, is the conversion of over 85 per cent of the sucrose originally present in the nectar through the action of an enzyme secreted by the bee. The nectar is further modified by the bee by the introduction of a minute quantity of formic acid which

is not present in the original nectar. This acid is supposed to act as a preservative and to prevent fermentation.

In an article describing his experiences in bee keeping, Dallas Lore Sharp in Harper's Magazine of September, 1922, writes interestingly about the transmutation of nectar into honey.

"All flowers do not yield honey, or any flower indeed. Only bees yield honey. Flowers yield sweet water—those that flow for the bees—a sweet water which may be ravishingly perfumed and tinctured with distillations as of attar and frankincense and myrrh, but whose sweet taste is that of cane sugar only. This sweet water the bees suck from the flower tubes and carry home in their abdominal honey sacs, and on the journey in the body of the bee the sweet secretion of the flower, to which has been added a minute drop of acid secretion of the bee, undergoes a chemical change, resulting in a new compound called honey.

"As the drop of nectar is sucked from the flower tubes it receives in passing certain glands at the root of the bee's tongue an infinitely small drop of formic acid, and the change into honey begins. The bee hurries home with her load, but instead of running to the empty cell with her sac of sweets, she is met by a home worker who, mouth to mouth, drinks from her sister's sac, emptying its contents into her own honey sac and adding her own portion of acid, thus doubly charging the nectar, as we charge the fruit juice at the fountain with a dash of acid phosphate; and the sweet water, which had been sweet with cane sugar, is now, from out of this second bee's abdominal sac, poured into the cell of the comb as real honey, sweet with grape sugar, not cane sugar, a different product, the joint chemical compound of many blossoms and at least of two bees."

MAPLE SUGAR AND SYRUP

Maple sugar and syrup are the products of the condensed sap of the sugar maple *(acer saccharinum)*. The North American Indians were probably the first manufacturers of maple syrup. In order to obtain the sap, a hole about half an inch in diameter is bored in the trunk of the tree to a depth of two or three inches. A metal spout is then driven into the tree just below the opening. A pail is attached to the spout to collect the sap which contains about three to six per cent sugar. The impurities are removed during the boiling process. The tapping of the trees begins in February and sometimes lasts until the middle of May.

The manufacture of maple sugar which is made by further concentration of the syrup, is mostly carried on in the northeast-

ern part of the United States, wherever maple trees are abundant. New York and Vermont lead in the production of maple sugar and syrup, which totalled nearly thirty-four million pounds in 1922. The production of maple sugar amounted to over four million pounds. In the early history of the American Colonies, honey and maple sugar were the chief sweetening substances, and they are certainly more wholesome than the refined sugar of the cane or beet.

CHAPTER VI

Milk and Dairy Products

Milk, and the many products made from it, were among the last articles added to the diet of primitive man, who was forced by circumstances to supplement at times his meagre diet with foods derived from the living animal. Milk is taken from various animals, such as cows, camels, mares, goats, sheep, reindeer and even the buffalo. After years of careful selective breeding, the cow and the goat have become especially adapted to the process of milking, and in some instances certain types of these animals, like the Holstein cow and the Toggenburg goat, produce at intervals enormous quantities of milk, especially during the season when plenty of green fodder is available. There are now over twelve million milch cows in the United States; Wisconsin, New York, Iowa and Minnesota are the leading dairy states, having nearly as many milch cows as the rest of the states combined. The large extension of the dairy industry in the United States is illustrated by the fact that over $1,000,000,000 is spent for milk and butter every year; about as much as the expenditure for cereal products.

Natural history shows that milk is supplied by nature only for the nourishment of newly born mammals, and the supply is cut off automatically after the period of lactation, which varies for different species from one month to about one year. We cannot, therefore, say that milk is in any sense a natural food, or is indispensable to the healthy growth and nutrition of the young after weaning. The young mammal is absolutely dependent for its normal development on its mother's milk, but the suckling period is comparatively short with all species of mammals, and the transition period to the food assigned to them by nature according to their anatomical structures is very rapid.

In a natural state the lactiferous glands of mammals are only active until the teeth of the young have grown sufficiently to enable them to take solid food. The milk glands of the mother would naturally dry up again, if the artificial milking of the animal were not increased by special breeding. In making milk a product

of commerce we interfere with the order of nature, as it is quite obvious that this complete food was intended only for the suckling of the young, and should not come in contact with the air. There are certain electric and magnetic properties in milk that dissipate rapidly when exposed, and which cannot be determined by chemical analysis. Furthermore, milk in every instance contains a certain amount of solid substances, which includes the nutritive elements in such proportions as are necessary to build up the tissues, bones, and different organs of the new-born animal. Nature provides in milk the kind of food needed by the young of the different species for their growth and development, according to the anatomical structure of their bodies. It is evident, therefore, that the chemical composition of milk in the various species of mammals must differ as widely as do their anatomical peculiarities.

There is another distinguishing feature in milk that is seldom recognized. Only a small quantity of iron is derived from milk during lactation. Nature has provided for this contingency by storing up a sufficient amount of this important element in a readily assimilable form in the liver of the young during pregnancy, to protect the growing organism against any deficiency. In milk this element is often deficient and not so readily available as the iron compound of the liver, which can enter directly into the circulation. This important fact has been explained at length in Chapter XII and should certainly be given due consideration in feeding infants.

Calcium is another element that varies greatly in the chemical composition of milk, especially in the case of milch cows. The constant removal of phosphate of lime by milking exerts a great strain upon the organism of the animal, which often draws a supply of this element from her own skeleton. In fact, the loss of calcium from the body appears to be a prominent factor in the nutritive depletion and functional derangement of the overtaxed milch cow, resulting frequently in tuberculosis. The ability of a cow to assimilate calcium is much more definitely limited than its ability to assimilate nitrogen.

While milk produced under ideal conditions is perhaps better than many of the artificial and demineralized foods of commerce, especially if supplemented with green leaf vegetables and fruits to supply organic iron, we are not justified in recommending its

indiscriminate use. For it is far from being indispensable for the maintenance of the health and vigor of the race. Milking of animals is an unnatural process since it lowers their vitality and makes them often victims of disease, while it gradually impairs the quality of the milk.

The Japanese are a healthy, virile, and progressive race, yet they use hardly any milk. In fact, they are averse to it. Artificial milk substitutes for bringing up children are unknown in Japan, except perhaps in the coast cities. The densely populated area of the country requires intensive agriculture and does not permit cattle raising. This is still more significant when we consider the fact that the land necessary for the feeding of a milch cow can under intensive cultivation support at least five people, if they live directly on the products of the soil. Greece and Rome at the time of their ascendancy consumed practically no milk, and dairy products were used only in limited quantities. Caesar's legions conquered the world on a diet consisting mostly of wheat and dried fruits; and they began to mutiny when meat was substituted for cereals.

The tables in the appendix giving the analyses of human milk and the milk of various mammals, show the following differences in their respective chemical composition:

Water content varies	from	70.00 to 90.00	per cent
Protein	"	1.30 to 15.30	" "
Fat	"	1.20 to 10.50	" "
Milk sugar (highest in human milk)	"	2.00 to 6.25	" "
Mineral matter	"	0.40 to 2.60	" "

The highest percentages of protein, fat and mineral matter are found in the milk of the rabbit, one of the most rapidly growing mammals. There is also, naturally, a great variation in the amount of the different organic salts.

The principal nitrogenous compounds of milk are casein and albumin in varying proportions. Human milk contains 1 per cent casein, and 1.2 per cent albumin; cow's milk, 3 per cent and 0.5 per cent; and goat's milk 3.2 per cent and 1 per cent, respectively.

When milk is drawn from the cow the casein is in a form called "caseinogin," and is changed by the action of the air into casein. The albumin is similar to that contained in blood, and in the whites of eggs. Besides, there are traces of other nitrogenous substances present.

The fat of milk is commercially the most important of its constituents, since it is the source of butter, and enters largely into the composition of cheese. Milk fat consists of several different kinds of fat, chiefly stearin, palmitin and olein. The total amount of fat in cow's milk should not fall below 3 per cent and does not generally exceed 4 per cent. A good average is about 4 per cent, or about 30 per cent of the water free contents of milk.

The carbohydrates of milk exist in the form of lactose or milk sugar, which is similar in composition to cane sugar, but not nearly so sweet. Its amount ranges from 4 to 6 per cent, but on the average is about 5 per cent in cow's milk. Human milk is the richest in sugar. In regard to the percentage of organic salts, mare's milk appears to resemble human milk more than any other. Goat's milk shows the largest amount of iron, while the amount of calcium is largest in rabbit's milk and smallest in human milk, which corresponds to the time necessary for the respective animals to mature.

The vitamin contents of milk vary greatly, perhaps more than in any other food product. As early as 1914 Casimir Funk, summing up the findings of various investigators, stated that vitamins were not found in milk in constant quantities, that they might be almost completely lacking, if the diet of the mother contained too small an amount of them. He found that in winter, when green fodder is scarce, cows produce a milk which is very deficient in vitamins, as compared with summer milk, when the animals are on pasture. In 1916 McCollum likewise found that vitamins pass into the milk only when they are present in the diet of the mother, and that milks may vary in their growth-promoting power according to the diets of the lactating animals. It has been shown that vitamin "*A*" in milk and butter always varies with the amount of this substance in the ration of the cow. In the summer when the pasturage was dried up, vitamin "*A*" was materially diminished in milk and butter. Further experiments clearly proved the relation between the quality of milk and the feed. Two cows, a Jersey and a Holstein, both fresh in December, were fed on a ration deficient in vitamins from January until June. They were then given the same combination of grains, but had constant access to grass. The milk was fed to guinea pigs to test its nutritive value.

Judging from the growth of the animals, the summer milk was three times richer in food content and antiscorbutic potency than the winter milk. It was but natural that the amount of alkaline elements had been likewise increased. Children's diseases, which occur most frequently in the early spring months, are most likely caused by milk from cows which have been fed poorly during the winter months.

Mother's milk, again, shows a great variance in its composition, according to the quantity and quality of food taken. The average composition shows the following proportions in 1000 parts:

	Average normal composition:	In cases of faulty nutrition:
Water	874.0	901.1
Casein	10.3	7.3
Albumin	12.6	8.7
Fat	37.8	28.3
Milk Sugar	62.1	52.7
Mineral matter	3.1	1.7

In Chapter VI, Part I, it has been shown that towards the end of the lactation period the percentage of protein in mother's milk gradually diminishes, as the growth of the infant is fastest during the early months, when large amounts of casein and albumin are required.

The mammary glands of the nursing mother secrete, between the third and sixth month after child birth, from 2¼ to 3 pints of milk per day, the amount gradually increasing up to end of the first year, when the child's teeth are sufficiently developed. Through the milk the mother secretes a part of the constituents of the blood plasma. If this is rich in phosphates, or in lecithins, the milk will also show large amounts of these constituents. Mother's milk is readily affected by the use of alcoholic beverages, strong coffee, tea, narcotics, drugs, all of which should be especially avoided during pregnancy and lactation.

The milk of tubercular cows presents, under the microscope, agglutinated globules like mucus. The leucocytes are distinguishable by their insolubility in ether. Sterilization of milk, as a means of protecting the child, destroys the soluble ferments and vitamins of the milk, and alters the taste and organic composition, while a portion of the casein is coagulated. Boiled milk, so often recommended, is therefore less nutritious than raw milk, which is always

preferable for infant feeding, provided it comes from a properly fed and cared for animal.

Various formulae intended to replace human milk by modified cow's milk have been extolled, but they can never imitate the highly organized compounds which nature has evolved during the long processes of evolution and which are best adapted for the healthy growth of the new-born infant. So-called modified cow's milk may appear to the analytical chemist to be a good imitation of human milk, because its proportion of proteids, fats, and sugars are similar, but the fact remains that the discrepancy is very great, especially in regard to the quality of the casein and proportion of the organic salts. Indeed, modifying milk for infant feeding is one of the greatest and most tragic blunders of so-called medical science.

Likewise the much advertised infant foods can only produce injurious results in the course of time. Although they may effect an immediate gain of weight and fatten the infant, it is usually at the expense of its vitality.

Cow's milk is an entirely different chemical composition and organic structure from mother's milk, and is, therefore, very different in its effect on the infant. It contains too large a percentage of casein and not enough albumin and milk sugar. Furthermore, the fat globules of cow's milk are sometimes so large that, instead of passing through the mesh-like lining of the delicate intestinal wall of the child and thence into the circulation as nourishment, they form a greasy, adhesive coating, and thereby interfere with the proper functioning of the mucus membranes. While children apparently may thrive on cow's milk, the tissue formation resulting from such a diet is not normal, the digestive power is overtaxed and the vitality is reduced.

Another point cannot be too strongly emphasized here. Milk is of value to growth and development only to the extent that it can maintain a perfect balance and integrity of its elements. Its normal temperature when drawn from the mammary glands is 97 degrees F. At that moment it is charged with animal magnetism and vital electricity which are quickly dissipated as soon as the milk is chilled by refrigeration or heated by pasteurization. Furthermore, since milk is often taken from diseased cows, its daily use is not recommended unqualifiedly. Its merits are often ex-

aggerated by those whose chief interest is the promotion of the sale of dairy products.

The digestion and growth of a calf differ materially from that of an infant. The chief characteristic of cow's milk is its ready coagulation into large curds, which are only with difficulty digested by the infant, whereas human milk coagulates into fine soft curds containing much less fat, and easily acted upon by the gastric juice. At the end of forty-five minutes, following a feed of cow's milk, the stomach contents of a child reveal casein clots still undigested; furthermore, the mineral elements or organic salts of cow's milk, chiefly lime, are not properly assimilated by the child, fully one-third being lost in the bowel discharges. The mineral salts of cow's milk are more than twice as abundant as in human milk and in different organic combination. In contradistinction to the organic salts in human milk, they frequently act as an irritant in the human organism, even when artificially reduced to the same or lower percentage found in breast milk.

Some people labor under the delusion that regardless of how filthy cow's milk may be, or how many germs it may contain, pasteurization or sterilization renders it a fit food for children. As a matter of fact, prolonged boiling does not kill the spores of all bacteria, nor are the chemical poisons produced by certain germs altered by the temperature of boiling milk. The first noticeable effect of using sterilized milk is that the child becomes constipated, and for this reason alone it is decidedly objectionable. The same objections may be urged against condensed milk, which probably does more harm than any other infant foods.

Cow's milk, if used at all, should come from clean and healthy animals that live in the open. It should be handled in scrupulously clean vessels and used as soon as possible. As a rule the feeding of the cow is far from ideal. There is a tendency to use many by-products of breweries, oil factories, and even a product made from chemically treated sawdust!

Alfred McCann in his excellent book, "The Science of Eating," mentions a case where one of the largest meat packing houses of New York City was compelled to discontinue the slaughter of dairy cows, because of the tremendous losses sustained through the excessive number of condemnations resulting from generalized tuberculosis. On the killing floor these cows could be milked, dem-

onstrating that they had been producing up to the time of slaughter. The carcasses frequently contained well-developed embryos, known to the trade as "bob veal."

In one certified herd in New York State, 124 out of 125 cows were found to be in a state of malnutrition, clearly indicative of the unfitness of their flesh for human consumption. The daily food supply of these cows consisted of: ten pounds of beet pulp (the exhausted residue of sugar beets); two to ten pounds of degerminated corn-meal and brewer's mash (exhausted refuse of alcoholic fermentation); ten pounds of alfalfa (the only good food used). To this mixture was added from one-half to one pint of oil meal or gluten feed. Oil meal is the residue of cottonseed after the oil is extracted. Gluten feed is the residue in the production of glucose from corn.

Many cattle feeds are impoverished and demineralized although they appear in the formulas of certified dairies, because they satisfy the modern dietitian's erroneous idea of scientific calories and a balanced ration. Besides, the feeding of cattle with artificially manufactured foods is always favored because of its cheapness.

A new artificial cattle feed has been lately recommended in the shape of chemically treated white pine sawdust. If treated with dilute sulphuric acid, and cooked under pressure with steam, this sawdust undergoes a chemical change and is partially converted into glucose, of which the resultant mixture contains from 14 to 18 per cent. The mixture is then neutralized by lime, the sugar dissolved, and the solution filtered and boiled down under pressure to the consistency of molasses. This mixture is then added to the partially dried sawdust residue, and a product closely resembling bran is obtained. It is needless to say that such food material will lead to a rapid deterioration in the quality of milk, and, by lowering the vital resistance of the animal, make tuberculosis a possibility.

Pasteurization or sterilization, still advocated by some physicians, in order to destroy germs and bacteria, impairs the nutritive value of the milk. Dr. E. M. Still, New York, says:

"It has been my fortune for a number of years to oversee the feeding of many hundred babies on pasteurized milk, and after numerous and careful experiments, I am forced to believe that in the vast majority of cases it produces rickets and scurvy, or

scrofulosis, and kindred diseases, if given continuously; all these diseases being cured by the use of raw milk, with no other treatment. Several years ago when there was so much talk of the virtue of pasteurized milk for babies, I examined several hundred babies so fed and found that 97 per cent of them showed signs of rickets, scurvy and scrofulosis, and it was only after these careful observations that the fallacy of heated milk in infant feeding was made known to me.''

Pasteurization of milk so changes its organic ingredients that it is no longer fit food for the proper nourishment of an infant. That commercially pasteurized milk is more unsafe than ordinary milk is abundantly proved by the investigations of Pennington and McClintock of Philadelphia and many other investigators. Experiments on the germicidal action of cow's milk have demonstrated that the relative increase of bacteria in milk is more pronounced if heated to 75 degrees C. or 100 degrees C. (167 degrees F. to 210 degrees F.) than in raw milk or milk heated to 56 degrees C. (132 degrees F.) proving that the heating of milk destroys or greatly impairs its germicidal action.

The disadvantages of cow's milk can be to some extent avoided by the use of goat's milk, which is far richer, more nutritious and more easily digested than cow's milk. The statement has been made that infantile paralysis does not exist where children are fed on goat's milk. While for ages people in all lands have thought that healthy goat's milk is good for well babies and excellent for ailing ones, the reasons were not fully understood and appreciated until a scientific study of the properties of goat's milk was made.

The fat globules of goat's milk are very small and resemble those of mother's milk, while the casein also forms smaller curds that are more easily digested than cow's milk. Moreover, it is known that the goat is the only dairy animal that has proved so far to be immune to tuberculosis. Thousands of children could not only be saved, but could also be well nourished by goat's milk, instead of cow's milk, especially where the supply is very liable to be contaminated, or is subject to wide variation, even though it may be obtained continuously from the same herd.

A diet of fresh cow's or goat's milk is best supplemented by small quantities of fresh fruit juice, preferably orange juice. The general opinion is that children should not be given fruit until the period of infancy is well passed. While this may be true of

fruits in general, the giving of strained juices of certain fruits is not only very beneficial, but actually essential to the baby when deprived of mother's milk. A teaspoonful of orange juice three times each day has been found to be very beneficial, especially in cases of rickets and other disorders caused by malnutrition. In giving fruit juices to infants several points have to be observed. The juices must be secured from perfectly ripe fruit, and carefully strained; they should be administered about two hours after feeding, and half an hour before the next feeding of milk. In nearly all cases the infants greatly enjoy this pleasant modification of their diet. While it is not necessary to give fruit juices to normal breast-fed infants, since healthful mother's milk is free from the deleterious qualities of artificial foods, it will be found most advantageous if the mothers themselves partake freely of fresh fruit. Fresh fruit juices are the best preventives of infantile diarrhoea, because their mild acid and alkaline salts are natural disinfectants of the alimentary canal.

Overfeeding is the most frequent mistake in the rearing of infants. Nearly all cases of colic and diarrhoea are due to this cause. A large number of infantile diseases can be overcome by regulating the hours of feeding. The child is not always hungry when it cries, and a few sips of water, especially during the night, will often produce good sleep, and give the stomach a needed rest.

Infant mortality remains one of the biggest problems that confront society. For years it has been the object of serious concern to governments and municipalities, not only in this country, but also in France, Germany and England. In spite of all that has been done, however, the total number of deaths among infants has not appreciably decreased. About 150 babies out of every 1000 die under one year from causes that are preventable. During the hot weather the rate in congested quarters is probably from 200 to 400 per thousand births.

The much dreaded and now frequently recurring infantile paralysis is a functional disease of the spinal cord, which, according to medical authorities, like any other endemic or epidemic disease, is caused by a specific germ. We may safely say, however, that indiscriminate feeding is at the root of nearly all children's diseases. Indeed so appalling is the ignorance of the majority of

people in regard to feeding and educating their children, that if nature had not endowed the growing organism with wonderful powers of resistance, the percentage of infantile paralysis, and other so-called infantile diseases, would be infinitely greater than it is. In almost every instance the death of a child is traceable to parental ignorance. Though many children survive despite irrational feeding, drug medication, vaccinations and serum therapy, they are handicapped for the remainder of their lives, since the infant's body loses a large amount of vitality in excreting these inoculated poisons.

While infantile paralysis appears to be epidemic, when we consider the fact that children—especially those reared in cities—are all more or less exposed to the same devitalizing influences, such as impure and pasteurized milk, as well as faulty nutrition, we shall come a step nearer to the origin of the fatal sickness. There is no doubt that the fundamental cause of all so-called contagious diseases is to be found in an impoverished condition of the blood and lowered vital resistance, resulting from the almost universal use of emasculated foods, deficient in the essential alkaline elements.

It is self-evident that an infant nursed by a mother whose diet is limited to devitalized cereals and vegetables, combined with meat, coffee or tea, will suffer in its own nutritional processes. The quantity of milk becomes insufficient and the quality defective, and the nursing period must be shortened for the sake of the poorly nourished mother, much to the detriment of the child. It is here that ignorance of the fundamental principles of nutrition becomes most fatal and far-reaching in its consequences.

It is impossible to over-emphasize the fact that the foundation of a strong and healthy body and power of resistance, must be laid by the mother long before the child is conceived and born, by a regulation of diet to insure a sufficiency of vitamins and blood and bone building elements, during pregnancy and lactation.

The changes to which milk can be artificially submitted are numerous. The principal one—skimming—consists in taking the butter fats from the milk either by spontaneous separation, or by centrifugal action.

The composition of the separated products are given in the following table:

	Normal Milk	Skim Milk	Cream
Water	87.25 per cent	89.70 per cent	58.63 per cent
Fat	3.50 " "	0.77 " "	35.99 " "
Protein	3.90 " "	4.02 " "	2.75 " "
Milk sugar	4.60 " "	4.74 " "	3.12 " "
Mineral matter	0.75 " "	0.77 " "	0.50 " "

Skim Milk as a rule is more easily digested than ordinary milk, and sours less readily. Most of the skim milk produced in the United States is used for stock feed. It contains about one-fifth of the fatty matters of the original milk, but almost the whole of the other substances. But skim milk, even with the addition of other fattening materials, can never produce the normal growth of the calf, as some of the vitamins and other elements are lacking.

Cream contains, besides fat, vitamins, lecithins and albumin, and a large part of substances that remain in suspension in milk, drawn along by the rising of the fatty globules. It is rather difficult to digest and easily sours because of the microbes which it collects from the milk. Large quantities of cream are consumed by the American people in the form of ice cream, a mixture of cream, sugar, gelatine, fruit or flavoring extracts, frozen in cans, which are rapidly turned in a mixture of ice and salt. Ice cream is certainly not a good mixture from a hygienic point of view, and should be eaten with discrimination, or dispensed with altogether. Its cooling effect is but of brief duration on account of its large fat and sugar content.

Whey is the clear or opalescent liquid that separates and remains when milk is coagulated by exposure to the air, or under the action of the special ferment of rennet, which transforms the casein into cheese. Whey contains about one per cent of the albumin; also some very small quantities of other organic matters (lactic acid, lecithins, etc.) and nearly all of the sugar and organic salts of milk, except the phosphates, the greater portion of which are carried away by the cream, or left in the coagulated casein. Whey is therefore more acid-binding than the whole milk.

Buttermilk is the liquid left by the churning of the cream of milk or the milk itself when the butter has been extracted from it, but in either case, it has nearly the same chemical composition. Buttermilk is richer in albumin than whey.

The following table gives an analysis of both whey and buttermilk:

	Whey from Cow's Milk	Whey from Goat's Milk	Buttermilk
Water	93.3 per cent	93.7 per cent	91.0 per cent
Albumin	1.1 " "	0.60 " "	3.5 " "
Fats	0.1 " "	0.02 " "	1.0 " "
Milk, sugar and lactic acid	4.7 " "	5.00 " "	3.8 " "
Mineral matter	0.8 " "	0.70 " "	0.7 " "

Koumiss is the product of alcoholic fermentation of mare's milk, and has long been used by the Tartars on the steppes of southern Russia and Siberia. It takes several days to complete its process of fermentation, after which a foaming, emulsioned liquid is obtained, of a taste at once acid and sweet, resembling almond milk. It contains alcohol in the same degree as light beer—about three per cent—and is, therefore, slightly intoxicating. In new koumiss the casein is in very thin flakes and dissolves readily if water is added.

Kephir is another alcoholic and sparkling preparation of milk, similar to koumiss. It is made by the inhabitants of the Caucasian mountains from the milk of their cows and sheep. The fermentation of this milk is induced by a specific agent, called kephir, and is said to have been handed down by Mahomet. The milk is poured into bottles of leather; the kephir powder diluted with lukewarm water is added, and the mixture stirred from time to time. After one or two days the liquid is ready for consumption. It contains much less alcohol than koumiss—only about 0.7 per cent.

Yogurt, another preparation of the Orient, is made of curdled milk of cows, goats or sheep, by boiling the milk over an open fire, concentrating it to about one-third of its volume. The remaining liquid is then poured into bowls, and, after it has sufficiently cooled, a little of the yogurt of the previous day's making is added. Four or five hours later a creamy curd is secured, which becomes solid and can be turned over without breaking apart. It can be kept for four or five days, after which it turns sour rapidly. In the East it is generally used in combination with a number of other foods.

Cheese in its numerous varieties is the product of curdled milk, more or less skimmed. It is formed mostly by the casein, which passes into an insoluble state by the action of rennet, retaining a

part of the lecithins, fats and organic salts. Cheese may be divided into fresh and cooked cheese, and in its turn may be fermented, salted or non-salted, containing more or less fat according to the quality of the milk from which it is made. Goat's and sheep's milk are also used in manufacturing cheese. The famous Brie cheese *(fromage de Brie)* is made from cow's milk, submitted to rennet at 95 degrees F.; Mont-Dore from goat's milk, and Roquefort from a mixture of the very fat milk of the sheep and goat, heavily salted. Fresh, unfermented cheeses are made from cow's milk. The best known are the Savoy, Swiss or Neufchatel varieties, which are the richest in fats.

In the process of ripening cheese, a portion of the casein is peptonized, while at the same time some odoriferous substances are formed, which give to each variety of cheese its peculiar aroma and flavor. These vary according to the nature of the micro-organisms, which slowly bring about the ripening of the curd.

All cheeses are concentrated foods, rich in casein, fat, lime, phosphoric and sulphuric acids, besides containing from 3 to 4 per cent of table salt. They are, therefore, highly acid-forming foods, and if used at all, should be eaten in small quantities combined with fruit or vegetables. So-called cottage cheese, made from whole milk, unsalted, is the most wholesome form of cheese. Analyses of three kinds of cheese is herewith given.

	Cottage Cheese	Swiss Cheese	Parmesan Cheese
Water	72.00 per cent	38.00 per cent	31.80 per cent
Casein and albumin	20.90 " "	25.35 " "	38.60 " "
Lactose and lactic acid	1.00 " "	1.40 " "	2.00 " "
Fat	4.30 " "	30.25 " "	21.30 " "
Mineral matter, including table salt in Swiss and Parmesan cheese	1.80 " "	5.00 " "	6.30 " "

The American people spend about 50 million dollars, annually, for cheese, of which over 5 million pounds are imported. The leading cheese producing countries of the world are Canada and

Holland, with an annual export of nearly 150 million pounds each; Switzerland, Italy and New Zealand each export at least 70 million pounds annually. Denmark, which exports 200 million pounds of butter annually, leads all other countries in this respect.

The World War has given the dairy industry of the U. S. a great impetus, as imports were practically cut off for several years, and consequently many of the European types of cheese are now manufactured here.

EGGS

Eggs constitute another large item in man's food supply. The American people pay about 500 million dollars for various kinds of eggs every year. The annual consumption of hen's eggs—the kind most commonly used—amounts to about 16 dozen per capita. In addition, eggs of the guinea fowl, turkey, duck and goose are frequently used, while in South Africa ostrich eggs are considered as being of excellent quality for culinary purposes. The demand for eggs of wild birds has decreased in proportion to the domestication of barnyard fowls. Turtle eggs also occasionally adorn the American bill of fare.

Like the seeds of cereals and legumes, each fertile egg contains a germ, or embryo. This embryo is a storehouse of material for the growth of the young bird until it has reached such a stage in its development that life outside the confinement of the shell becomes possible. The embryo is in close relationship with the yolk, which furnishes the material for its early development, the white being used later. The yolk and white of the egg must naturally differ in chemical composition, according to the purpose subserved. The analyses of the different parts of the domestic hen's egg given below is typical for all other varieties of eggs:

	Whole egg without shell	White of egg	Yolk
Water	73.70 per cent	85.75 per cent	50.80 per cent
Protein	12.55 " "	12.70 " "	16.20 " "
Fat	12.10 " "	0.25 " "	31.95 " "
Carbohydrates	0.55 " "	0.70 " "	0.10 " "
Mineral matter	1.10 " "	0.60 " "	1.10 " "

Composition of mineral matter in 1000 parts of water free substance.

	Whole egg	White	Yolk
Potash	6.27 per cent	13.21 per cent	2.70 per cent
Soda	9.56 " "	13.30 " "	1.44 " "
Lime	4.56 " "	1.18 " "	3.17 " "
Magnesia	0.46 " "	1.18 " "	0.51 " "
Iron	0.17 " "	0.25 " "	0.40 " "
Phosphorus	15.72 " "	1.85 " "	15.22 " "
Sulphur	0.13 " "	0.88 " "	
Silica	0.13 " "	0.45 " "	0.21 " "
Chlorine	3.72 " "	12.08 " "	0.45 " "

These figures show that eggs, containing as they do an excess of nitrogen and phosphoric acid, are a highly acid-forming food. For this reason eggs should be used in moderation, if used at all, and always combined with vegetables or fruits which are strongly alkaline, preferably salads made of green leaf vegetables.

The shells of hens' eggs, which are porous, are made up very largely of mineral matter, containing 93.7 per cent calcium carbonate, 1.3 per cent magnesium carbonate, 0.8 per cent calcium phosphate, and 4.2 per cent organic matter. The egg shells of other birds are of similar composition.

The albumen, or white of the egg, is essentially formed of ovalbumin, mixed with small amounts of ovoglobulin and fibrinogen. These three substances, mixed with water, are contained in little cells formed by the small membranes that divide and enclose the albumen. In boiling or frying the egg, the albumen begins to coagulate at a temperature of 160 degrees F. becoming white, opaque, and insoluble in water. One of the constituents of egg albumen is sulphur, and the egg albumen is readily decomposed by the liberation of hydrogen. The bad odor of decayed eggs is due to sulphuretted hydrogen. A large quantity of spoiled eggs is still surreptitiously used for baking purposes, despite the pure food law.

Egg yolk is made up of the following substances: about 30 per cent of fat in the form of palmitin, stearin, olein and lecithin, one of its highly important constituents; and 16 per cent of protein, mostly in the form of vitellin and albumin. The mineral matter is largely composed of phosphoric acid, calcium, magnesium and iron.

Eggs are occasionally eaten raw, or beaten with vegetable juices, but as a rule they are cooked and served in various ways,

each being merely a more or less elaborate modification of a few simple methods. Hard boiled eggs are more difficult to digest than soft boiled, unless they are very thoroughly masticated.

Coincident with the extension of poultry farming, the preservation of eggs has become a matter of importance. Among the various methods used with more or less success for the purpose of closing the pores are: burying the eggs in oats, bran or salt; dipping them in melted paraffin; covering them with a varnish or shellac; or immersing them in lime water or in a solution of water glass (silicate). The latter method is considered the most successful. The solution is prepared by dissolving one part of silicate with 10 parts, by measure, of pure water. The commercial preservation of eggs by means of cold storage is an industry which has developed greatly in recent years.

Preserving eggs by drying them is a common and often very satisfactory method. In China, where the poultry industry is of large proportions, millions of dozens of eggs are annually converted into dried form, dried yolks, and dried albumen (white of egg). By this method 100 dozen eggs may be reduced to a weight of 26 pounds.

Considering the fact that thirty-two eggs are required to make one pound of water-free food material, the nutritive value of the eggs is not as great as is generally supposed.

CHAPTER VII

Flesh Foods

In one of the preceding chapters it has been shown that meat eating is one of man's dietetic habits acquired comparatively late in the evolution of the human race. It appears that this deviation from natural diet was by no means voluntary, but caused by extreme want and necessity. It was either a question of eating what could be found near at hand, or perishing. During the thousands of years subsequent to great geological changes, the meat-eating habit established itself more or less firmly, except among those whose religious teachings proscribed the use of flesh foods and the slaughter of animals.

Many persons believe that one of the contributing factors to the superiority of the Caucasian race has been the large consumption of flesh foods. This, however, is merely a coincidence. The inhabitants of the temperate zones had a more severe struggle for existence than those living in tropical climates, and consequently developed their mental and physical qualities to a higher degree. Caucasians are foremost among the races of the world not because they are more or less meat eaters, but because during thousands of years they have possessed the advantage of a cold, yet salubrious and invigorating climate, in which they could develop their prowess and skill by constantly coping with the adversities of nature. While food has played an important part in the evolution of man, there can be little doubt but that the most potent factor in the great increase of his cranial development and thought force has been the severe struggle for existence. It is apparent that in the course of evolution man gained ascendency, not so much by his physical strength, but by the development of his higher mental faculties, which enabled him to successfully cope with the adversities of nature. The growth of man's spiritual forces will finally lead him out of the age of barbarism in which he is still living.

Perhaps no word in the English language has suffered from so many false interpretations as "vegetarianism." This is due mainly to a confusion of the words, "vegetarian" and "vegetables." To

the average man a "vegetarian" signifies a vegetable eater—one who lives on vegetables exclusively. The word vegetarian is derived from the Latin word, "vegetus," which means strong and vigorous. Again, many who criticize vegetarianism, frequently point to the teeming millions of eastern Asia as examples of those that abstain more or less from the eating of flesh food, and are dominated by the European nations. These people are the victims of unfavorable social and economic conditions, and the majority of them lead an almost hopeless life of slavery. That the meat eaters have conquered the world is so generally believed as to have become an aphorism. The Anglo-Saxon race without question has been successful in bringing under subjection innocent people whose religion, for the most part, forbids the shedding of blood, but the conquest has been effected by brute force and by the power of guns rather than by bringing into play any higher mental faculties. The conquests of ancient Mexico, Peru, India and Africa, have to all appearances been complete, yet recitals of these predatory wars constitute dark pages in the history of civilization and are examples that should not be emulated.

An exhaustive investigation of the subject of flesh foods leads every unprejudiced thinker to the inevitable conclusion that from a purely scientific viewpoint their use cannot be justified. Of course, there are those who are influenced by habit, fashion, or commercialism, or who are forced to live mostly on meat in the absence of other foods, such as the natives of the North. Attention, however, should be called to the fact, that the Eskimo does not subsist entirely on meat. Many green herbs and weeds, also salmon berries are eaten during the short summer season. A seaweed common in the north is eaten quite largely. We must also remember that the Eskimo eats his meat raw without the addition of salt or condiments, that he preserves the blood and partakes frequently of the animal's organs, which contain some vitamins and mineral elements lacking in the muscular tissues. If the arguments of those who declare meat essential for the development of a superior mentality were true, the Eskimos should be the most intelligent race on the globe.

In all cases where due attention is paid to a well-balanced supply of organic salts in food, the vegetarian diet is successful and increases one's powers of endurance both physically and mentally.

Abstinence from flesh foods alone, however, by no means insures health. In fact, unless accompanied by an otherwise rational diet, vegetarianism is often a retrogressive step. This is especially true if white flour products, concentrated sweets and badly prepared vegetables are used.

As a rule, journalistic writers on the diet question appear to be mainly concerned in justifying the prevailing habits of the communities in which they live, and for the sake of popularity are disposed to condone human frailties. It is largely because of the pernicious activity of these people that prejudice against vegetarianism in this country is so general and the subject is so belittled and misunderstood. While a large number of individuals have profited by adopting a sensible meatless diet, there are at present very few communities that are *strictly* vegetarian; and these for the most part are made up of people whose religion debars them from killing animals for food. The inhabitants of northwestern Europe, the United States, Canada, Argentine Republic, Australia, New Zealand, and the Arctic zones may be termed meat eaters, as their diet contains a large part of flesh food. The inhabitants of the Mediterranean countries of eastern and southeastern Asia are practically vegetarians, as they eat fleshfoods only occasionally, and then only in moderation. From this point of view about one-fourth of the earth's population use meat as a daily food, whereas three-fourths are living on a more or less meatless diet. In all European cities the per capita consumption of meat is much higher than in the country, while in the United States, Canada, and perhaps the Argentine Republic, the consumption is about equally divided between city and country.

The following table shows the estimated per capita consumption of meat in the U. S., in pounds, from 1907 to 1921:

Kind	1907	1908	1909	1910	1911	1912	1913	1914
Beef	79.7	72.4	76.2	71.8	68.4	61.7	60.8	58.9
Veal	7.1	6.8	7.5	7.4	7.0	7.0	5.0	4.4
Mutton and Lamb	6.4	6.2	6.6	6.5	7.8	8.2	7.5	7.5
Pork	74.1	85.4	68.6	60.3	75.1	70.6	72.5	69.9
Goat	0.1	0.1	0.1	0.2	0.1	0.2	0.1	0.2
Total	167.4	170.9	159.0	146.2	158.4	147.7	145.9	140.9

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Kind	1915	1916	1917	1918	1919	1920	1921
Beef	55.7	58.1	62.0	64.8	57.3	61.1	57.7
Veal	4.3	5.3	6.5	7.6	8.2	8.9	8.3
Mutton and Lamb	6.4	6.2	4.7	4.7	5.8	5.0	6.1
Pork	72.0	75.7	58.4	68.9	67.1	68.9	72.8
Goat	0.2	0.2	0.2	0.1	0.1	0.1	
Total	138.6	145.5	131.8	146.1	138.5	144.0	144.9

The total quantity of meat consumed year by year shows only a limited variation. But the steadily increasing population has brought about a considerable decline in the per capita consumption. For the first five years in the table, from 1907 to 1911, the per capita consumption averaged 160.4 pounds while for the last five years, from 1917 to 1921 the average was 141.1 pounds. Thus in about ten years there has been a decrease of 19.3 pounds, or 12 per cent, in the per capita consumption.

The year 1908 shows the highest per capita consumption with 170.9 pounds, and the lowest was 1917 with 131.8 pounds. It will be remembered, however, that this was the year when war was declared against the Central Powers of Europe and the marketing of meat was consequently restricted. Fifty per cent of the meat consumed in 1908 was pork, and the average price paid for hogs that year in Chicago was $5.70 per hundred pounds, while in 1917 the proportion of pork to total meat had fallen to 44 per cent, and the average price paid for hogs in Chicago had risen to $15.10 per hundred pounds.

For comparison with the United States, the meat consumption in other countries is given in the following table. The figures in each case cover pre-war periods and are an approximation of the normal yearly per capita consumption in the various countries:

Argentina	281	lbs.	Belgium	70	lbs.
Australia	263	"	Netherlands	70	"
New Zealand	212	"	Greece	68	"
United States (10 year av.)	142.4	"	Austria Hungary	64	"
			Norway	62	"
Canada	137	"	Sweden	62	"
Cuba	124	"	Poland	62	"
United Kingdom	120	"	Russia	50	"
Germany	115	"	Spain	49	"
France	80	"	Italy	46.4	"
Denmark	76	"	Japan, meat	1.5	"
Switzerland	75	"	Japan, fish	25	"

Only three countries have a larger per capita consumption than the United States, and these countries having a very sparse population are now the great sources of the world's supply of beef and mutton. In six countries statistics are available in regard to the proportion of each kind of meat. These figures indicate that Argentina consumes the most beef; the British meat dietary has the closest balance of beef, mutton and pork, while the Germans are relatively the greatest pork consumers.

The great meat-packers of the United States are becoming aware of the fact that the consumption of meat is gradually declining, and although there is no immediate danger that the people will cease eating meat, the packers realize that they must do something to protect their industry which represents a gigantic investment of many million dollars. They have recently inaugurated an "Eat more meat" campaign, and it is a deplorable fact that the United States Department of Agriculture is very much interested in helping the cause of the meat-packers by publishing a number of posters which encourage the use of meat. Of course doctors and chemists in the employ of the packers are trying by all means to increase the consumption of flesh foods by publishing misleading arguments in order to extol the nutritive value of meat, but the Department of Agriculture should at least refrain from such activity.

At the seventeenth annual convention of the Institute of American Meat Packers, October, 1922, in Chicago, Dr. W. D. Richardson, Chairman of the Committee on Nutrition said:

"It must be apparent to all of you, that in order to overcome the falling off in the per capita consumption of meat, which has been emphasized upon more than one occasion, you and all the interests and individuals whom you represent must believe in meat as a fundamentally desirable human food-stuff, and not only that, but you must know the scientific and clinical facts in regard to the nutritional value of meat, and its proper place in the diet of the child, the adolescent, the adult, the old, the laboring man, and the brain-worker, in order to meet any arguments which may be put to you."

Dr. Richardson called attention to the dearth of literature on the nutritive value of meat and took up the question of proteins in meat. He pointed out the high percentage of protein in meat

as compared with other foodstuffs and also called attention to the phosphorus and iron that are contained in meat. Said Dr. Richardson:

"A few members of the medical profession, lacking complete knowledge of their subject, have given out the idea that there is possibly something harmful about meat, that there is a possibility that one might eat too much meat and that if it is not harmful in small quantities, it may be harmful in large quantities; naturally, many people have believed what has been told them by these misinformed physicians and have taken up the cry that there may be something harmful in the eating of meat, certainly in excessive meat eating. This committee stands for the mixed diet, the so-called balanced diet in which meat has a prominent place. It does not recommend an exclusive diet of meat, but, nevertheless, the fact is true and should be emphasized that when meat and meat products make up the entire supply the diet is a perfectly satisfactory one as shown by various tribes of Eskimos."

Dr. E. B. Forbes, specialist in nutrition, of the Institute of American Meat Packers, in an address delivered before the Chicago Housewives' League, at their meeting in the Fine Arts Building, March 13, 1922, brought out the following arguments in favor of meat:

"Meat proteins have a superior nutritive value because they more closely resemble the tissues which are to be nourished than do other proteins, and can be transformed with less loss.

"An especially marked superiority of meat as food is in its relation to the nourishment of the blood. Whipple and associates at the University of California Medical College found that beef muscle, heart and liver were much superior to bread and skim milk for restoring the blood to normal in simple anemia. They also found that Bland's pills and other iron containing drugs were quite without value for purposes of blood regeneration. Their best results were obtained with heart and liver.

"As a matter of practical dietetics no nutritive consideration compares, as a motive for eating meat, with the fact that we like it.

"Meat also has a capacity, recognized by all physiologists, to stimulate the vital processes, which contributes a feeling of vigor and physical well-being that makes it virtually an essential in the diet of working men, athletes and soldiers.

"Meat in the diet also has value in connection with the development of the teeth. Children reared on soft foods which require little mastication often suffer from lack of development of the jaw bones and alveolar processes, so that the teeth come through crowd-

ed, projecting, crooked. Spare the meat grinder, and save the teeth by teaching the child to use them. The aboriginal baby cut his teeth on a bone, and ate meat as soon as he could chew it. The child of two years has two teeth all the way around, back of the front set of four, above and below; and the United States Public Health Service advises the feeding of some meat to a child beginning at two years of age.

''In relation to disease, meat cures pellagra, and anemia, and, under appropriate dietary conditions, scurvy and beriberi as well. Phenomenal results were obtained in the Japanese navy in the cure of beriberi by substituting meat for white rice in the ration.

''The leading pathologists of the United States agree that meat eaten in moderation, during health, is not known to cause any disease. Stefansson has shown that it is possible to live year in and year out on meat alone, provided it is not so thoroughly cooked as to injure the scurvy-preventing vitamin.

''The gist of this whole matter is that we have new reasons for regarding meat highly, and we have no reason for departing from those habits as to meat eating which our own practical experience has led us to adopt.''

While most of the statements of Dr. Forbes are refuted elsewhere, a few may be briefly answered here.

Meat does contain a large amount of protein, an average of twenty per cent, but its contents of iron are very small. Physiologists consider the iron compounds contained in the blood and tissues of the dead animal of less nutritive value than those contained in fresh fruits and green leaf vegetables. Proteins derived from the vegetable kingdom are free from the waste products of animal life. It is not necessary to eat meat in order to build up healthy muscular tissues, any more than it is required to eat calves' brain in order to form brain cells. Each tissue receives its protein material in the form of amino acids from which the particular kind of protein characteristic of the tissue can be synthesized. In other words, each tissue makes its own proteins from the amino acids brought by the blood. All the amino acids necessary for building a strong and healthy body can be derived from fruits, nuts and vegetables. The daily amount of protein needed is far less than that stated in the old physiological text books.

It is preposterous to recommend heart and liver, an organ teeming with waste products (nearly 20 grains of purins per pound) for their nutritive contents when the purest and most

prolific sources of the same elements are fruits and green leaf vegetables.

To encourage meat-eating because people have learned to like it, is on par with promoting the consumption of alcoholic beverages, artificial sweets, stimulants and narcotics, because many people have become addicted to the use of them. The perverted taste of civilized man is very unreliable as a criterion for judging the necessity for flesh foods in human nutrition.

Meat is stimulating according to the amount of waste products (purins) it contains. In athletic contests in Europe, where endurance is the main factor, vegetarians have been as a rule the victors. Carbohydrates, especially in the form of natural sugars, and not proteins, are the main sources of physical energy.

The lime content of meat is also low. It is one of the poorest materials for building teeth. Almost all the lime is contained in the animal bones, and in this form it is not available for human nutrition.

It has been found that if the Japanese soldiers are fed on natural brown rice, onions and green leaf vegetables, beriberi and scurvy disappear. These diseases are caused by a deficiency of alkaline elements which are best supplied by fresh fruit and vegetables.

A vigorous man can live on a more or less exclusive meat diet for a time in an arctic climate, but he will overwork his kidneys and shorten his life. One of the reasons why the Eskimos manage to live on a more or less exclusive meat diet is that they preserve the blood of the animal, in order to have some of the necessary mineral elements, especially iron. As already stated, the Eskimo supplements his meat diet with vegetable products whenever he can do so.

Meat can at best be termed a second class food and is by no means essential for the acquisition or maintenance of physical or mental strength. *In the muscular tissues of the dead animal the vibratory forces of nature are in the descendency. They have been lost in the production of animal heat, energy, electricity and magnetism. In the products of the vegetable kingdom, if used in their natural state, the vibratory forces are in ascendency, and exert*

their full and beneficial influence on the physiological functions of the body.

The word "meat" is generally applied to the muscular tissues of the animal, deprived of blood, bone and rolls of adipose tissue. On an average, lean meat contains about 72 per cent water, 20 per cent protein, 5 per cent fat, 2 per cent extraction matter, and 1 per cent mineral matter. The protein is made up of a number of amino acids, but not sufficient to be conducive to growth. Lean meat is deficient in vitamins "A" and "B," and contains only a small amount of vitamin "C." It has, therefore, little antiscorbutic value. Tinned and pickled meats are practically valueless in this respect. The extractive matters contain most of the waste poisons (purins) ammoniacal salts, urea, uric acid and other xanthic bodies, which give meat some stimulating effects, generally mistaken for strength-giving properties.

The mineral matter in 1,000 parts water-free meat is composed as follows:

Potash	16.52 parts	Phosphoric acid	17.00 parts
Soda	1.44 "	Sulphuric	0.64 "
Lime	1.12 "	Silica	0.44 "
Magnesia	1.28 "	Chlorine	1.56 "
Iron	0.15 "		

Phosphoric acid, which is chiefly contained in the nucleins, is combined to the extent of two-thirds with potash; another part not finding sufficient bases, renders the mineral matter acid. The sulphuric acid comes from the sulphur of the albuminoids. Meat, besides containing a number of xanthic bodies, forms additional waste poisons and acids in the digestive process.

The following table shows the amount of purin bodies in flesh-foods and other food products; also the chemical composition of the principal xanthins and alkaloids. Attention must be called to the fact that if the meat comes from diseased animals the amount of poisonous waste products is very much increased.

Purin	$C_5H_4N_4$	Adenin	$C_5H_5N_5$
Hypoxanthin	$C_5H_4N_4O$	Guanin	$C_5H_5N_5O$
Xanthin	$C_5H_4N_4O_2$	Caffein	$C_5H_1N_4O_2$
Uric acid	$C_5H_4N_4O_3$	Theobromin	$C_5H_2N_4O_2$

Amount of Purin bodies in grains, per pound:

Sweetbread	70.43	Beans	4.16
Beef Extract	45.00	Lentils	4.16
Liver	19.26	Oatmeal	3.45
Beefsteak	14.45	Peas	1.26
Sirloin of beef	9.13	Asparagus	1.05
Chicken	9.06	Onions	0.06
Loin of pork	8.48	Porter	1.35
Veal	8.13	Ale	1.27
Ham	8.08	Lager beer	1.09
Mutton	6.75	Coffee	1.70
Salmon	8.15	Ceylon tea	1.21
Halibut	7.14	Indian tea	1.05
Plaice	5.56	China tea	0.75
Cod	4.07	Cacao	0.50
Oysters	2.03		

As already stated, there is a marked physiological difference between the products of the vegetable kingdom and flesh foods. Plants are constructive. Their activity consists mainly of tissue building; while activity of the animal organism is two-fold—tissue destroying and tissue building. The animal body may be likened to a structure in which two opposite forces are at work; one tearing down, the other building up new tissues. Normal growth is the result of proper equalization of these forces. In the growth of the plant no destructive process has been discovered. If it exists at all, it must be very trifling in comparison. Protoplasm is taken from the older parts of the plant, and while these parts die, the protoplasm does not decompose, but is used again in tissue building. In the final analysis, flesh proteins are of less nutritional value to the human organism than plant proteins, because the former are always combined with a large number of substances that have undergone the various stages of catabolism and have lost their electric and magnetic tension in the performance of the various physiological functions of the body. While the living animal cell reaches a higher stage of evolution than that of the plant, the life of the former depends upon the continuous removal of the waste poisons, which remain and rapidly increase in the decomposing carcass of the animal. With every piece of flesh, therefore, the excretory organs, especially the liver and kidneys, are over-taxed by the additional poisons created in the tissues of the animal.

It has been found that in man the liver destroys only about one-half of the uric acid circulating in the blood, whether derived from external sources in the form of meat, or generated within the body by its own tissue changes. This is due to the fact that the liver and kidneys receive equal quantities of blood. In carnivorous animals, however, the liver is much more active, receiving a much larger food supply in proportion to that received by the kidneys. In fact, the liver of carnivorous animals is able to destroy from ten to fifteen times as much uric acid as the liver of a man, a fact which clearly indicates that the human constitution is not physiologically adapted to the proper digestion of flesh foods.

The meat of diseased animals—a large number of stable fed cattle suffer from various diseases—often contains poisons to a dangerous degree, and alarming quantities of such food are consumed throughout the country. Despite the fact that millions of pounds of meat, totally unfit for use, are confiscated every year, it is quite certain that, especially in the poorer districts of all our larger cities, immense quantities of objectionable meat that escape investigation are sold and thus endanger public health and life.

The once widely advertised "Liebig's Beef Extract," really concentrated beef broth, must be considered rather as a poisonous stimulant than a food. The small amount of nitrogenous matter it contains is more than offset by the large amount of creatin, creatinin, carnin and xanthin to be found in it, and also by the predominance of acid-forming elements. In every case where these extractives cause a temporary stimulating effect by increasing the action of the heart and arterial tension, they are followed by a decided reaction. Intelligent physicians, therefore, refuse to prescribe them and recommend alkaline fruit juices instead.

Some of the organs of the animal, such as the sweetbread, liver and kidneys, which are frequently used as food, contain toxic waste products to a much higher degree than the muscular tissues, especially when the animal has been in a diseased condition. The animal most subject to disease is the domesticated hog, especially if fed on decaying garbage, as is so often the case. Hogs are frequently infected with trichinae, which renders their meat particularly objectionable. Trichinae are also found in fresh water fish, such as the pike and salmon. On account of their rapid

putrefaction fish are especially likely to develop the highly poisonous ptomaines. This is also the case with oysters and crustacea that live near the mouths of rivers, or near harbors, into which drainage is discharged.

Another point may be mentioned here: carnivorous animals have atrophied inactive sweat glands, whereas in man, and frugivorous and herbivorous animals, they are well-developed. While in the course of evolution these glands were retained by the former as rudimentary organs, they have completely lost the habit of sweating, a circumstance that protects the carnivora against a sudden loss of water through the skin, and consequent retention and precipitation of waste poison in the system. We know that uric acid and its salts dissolve easily in warm water, but with difficulty in cold water—fifteen grains of uric acid requires one gallon of water at the body temperature for their solution. The fluid that keeps the uric acid and its salts dissolved in the body is the water contained in the blood and tissues. If the fluids of the body are suddenly diminished and cooled, as in the case of sweating, a precipitation of uric and crystals in the system will occur, causing serious disturbances.

Animals whose food constantly adds large quantities of waste products to those already in the body, must be provided with means to keep these substances in solution. This protection is given to the carnivorous animals by the atrophied sweat glands, which prevent a sudden loss of tissue fluids.

As man is subject to sweating, it is evident that he was not intended to live on meat and highly acid-forming foods, and while he may eat with comparative immunity a limited amount of these, it is well to remember that they should never constitute the principal portion of his diet.

The statement that animal protein is more easily digested than vegetable protein, is contradicted by the fact that in the actual rebuilding of the tissues of the body, the former has less biological value than the vegetable protein, which is free from the waste products of animal life, and, moreover, has a stronger vibratory force, as a result of having been developed from the soil under the direct influence of water, air, and sunlight. Furthermore, "the great protein delusion" that the adult human being needs from three to four ounces of protein per day has been exploded long

ago. The average man or woman has no use for more protein than about one ounce per day. What is furnished above this amount is made into sugar and starch and often into fat. The extra amount of protein means overwork for the liver and kidneys and increased blood pressure.

The temporary sensation of strength following a meal of flesh foods, experienced also in a similar degree after using alcoholic beverages, tobacco, coffee, and tea, is for the most part due to the stimulating effects of its various xanthin bodies, which the system seeks to remove by means of increased circulation, at the expense of latent vitality.

These circumstances frequently furnish ground for the statement that the use of meat is more conducive to brain work than a vegetarian diet. Herbert Spencer once said: "I tried vegetarianism for three months and found I was obliged to destroy everything I wrote during that period because of lack of meat." Spencer was a lifelong invalid and a chronic dyspeptic, and he had accustomed himself to the stimulating effects of meat. His diet was evidently not well chosen and was probably deficient in some of the organic salts. The inference is that he simply discarded flesh foods without otherwise improving his diet, and he was, therefore, by no means justified in condemning vegetarianism. Without doubt many others who have depended upon a meatless diet for a brief period, and who at the same time have persisted in consuming devitalized cereals and vegetables, will agree with Spencer.

The testimony of two celebrated ancient philosophers and writers, who lived in an age when wholesale food adulteration was practically unknown, furnishes a more reasonable and convincing basis of argument. Writing to his friend Firmus, who had abandoned the Pythagorean doctrine in order to eat meat, the philosopher Porphyry, living in the third century, said:

"I cannot believe that your change of diet is due to reasons of health, for you yourself have constantly affirmed that a vegetable diet is much more suitable than any other, not only to give perfect health, but even a philosophic and balanced judgment, as a long experience had taught you."

And Seneca, who, after studying the problem of nutrition for many years, had adopted vegetarianism, wrote:

"Struck by such arguments, I also have given up the use of

flesh of animals, and at the end of a year my new habits have become not only easy to me, but most agreeable; and it even seems to me that my intellectual aptitudes have become more and more developed.''

Isaac Newton adhered strictly to a vegetarian regimen while performing the prodigious intellectual work which made his name immortal.

Among the modern philosophers and artists who have followed or advocated a rational vegetarian regimen may be mentioned: Shelley, Byron, Thoreau, Tolstoi, Richard Wagner, Tagore, Maeterlinck, Alexander Pope, and George Bernard Shaw.

It is often asserted that fish, because of the phosphoric acid it contains, is particularly conducive to brain work. This assumption is largely based on Moleschott's saying: ''Without phosphorus, no thought.'' While it is undeniable that phosphorus is an important constituent of the brain, it still remains to be demonstrated in what manner this element is connected with mental activity. The proper functioning of the brain depends on the purity and proper circulation of the blood, and not on the presence of a single element. Oxygen is certainly more important than any other known element and its supply depends upon the presence of iron, which is deficient in the muscular tissues of fish. Mark Twain once wrote to a young writer of mediocre capability who asked the humorist's opinion about some of his writings, and incidentally concerning the value of fish as a brain food, that he would do well to eat a whale every day and thereby become a celebrated author, since it was said that a fish diet had a stimulating effect upon the mental activities!

A famous editorial writer who indulges occasionally in fanatical attacks on vegetarianism, some time ago treated his readers to the following bit of absurdity:

''The grass grows, and man can't eat that; he hasn't time to digest it. The ox eats the grass and man eats the ox. A meat diet is simply a time saving device. In an hour a man with a meat diet can restore his wasted tissues, using up very little vitality in the digestive process, living longer by so doing, and devoting his time to more important work than digesting.''

The idea that fleshfoods are in some manner pre-digested plant food, ready to be swallowed down and assimilated, is entirely erroneous both from a chemical as well as a physiological standpoint.

Meat, which is composed of the muscular tissues of the animal, is deficient in the important blood and bone building elements, and a man living principally on lean meat would slowly starve himself.

Carnivorous animals devour all of the blood and bones of their prey, and thus secure a sufficient supply of the elements to maintain life. In captivity, these animals, if fed mostly on lean meat, as in zoos, rapidly fail, and by degrees lose their reproductive powers. Their young show all the symptoms of rickets, but recover if fed frequently on whole rabbits or chicken, containing the blood and entrails.

The arguments against meat eating from the standpoint of physical strength and endurance are equally strong. Medical science is still suffering from Liebig's old theory that the human or animal muscle works on proteins, whereas as a matter of fact nearly all heat and energy are produced by fats and carbohydrates. It is now an established fact that the adult body cannot make use of more than about five per cent protein, of the total amount of solid food needed daily. A man, even at strenuous work, and consuming per day about twenty ounces of water free food, has no need for any excessive amount of protein, as it is not used as tissue building material, but is broken up into carbohydrates and burned up as such in the body. A diet containing a surplus of protein has, therefore, no advantage whatsoever. In fact, a surplus of protein overloads the system with waste poisons, and has only a temporary stimulating effect. Two ounces of protein per day, making allowance for incomplete digestion, amply covers the requirements of the most strenuous worker. (See table in the appendix, giving the amounts of various foods necessary to supply two ounces of protein.)

The most severe and conclusive tests of physical endurance and strength have been performed on a judiciously selected fleshless diet. The athletes of ancient Greece were trained entirely on a fruitarian diet. In nearly all modern athletic and endurance contests of Europe, the vegetarians have carried off the laurels. The boatmen of Constantinople who live on bread, figs and olives, possess wonderful physical development. The powers of endurance of the Japanese have been commented upon by many writers. In the Boxer Rebellion the Japanese outdistanced the allied troops in

marching, while during the Russian-Japanese War the recuperative powers of Japanese soldiers were often commented upon. Lately the use of flesh foods has been introduced into the Japanese army, and it will eventually lead to a deterioration in their general health and physique, and an increased liability to disease.

The Japanese themselves attribute their high average of physical strength to a plain and frugal diet, and to a system of gymnastics called "jiu-jitsu," which includes a knowledge of anatomy and the internal and external use of water. According to the British Medical Journal, in 1899 a commission was appointed by Japan to consider whether by a meat-diet, or by other means, the stature of the race could be raised, but the conclusion arrived at was, that seeing their feats of strength and powers of endurance were superior to races much taller than themselves, their small stature did not matter.

The annual per capita consumption of beef and mutton in Japan is surprisingly low, amounting to about 1½ pounds per capita as against about 142 pounds consumed in the United States. The per capita consumption of fish in Japan amounts to about 25 pounds. Most, if not all, of the meat used in Japan is consumed by well-to-do people in large cities. The greater part of the fish, also, is consumed by people in comfortable circumstances, especially in the coast regions. Methods of preserving fish are not yet highly developed. Moreover, among the rural population, the high price of fish prohibits its regular use.

The rural population of the interior depends very largely, or almost entirely, upon a vegetable diet. And this, it may be observed, practically means vegetarianism. The so-called lacto-vegetarianism is unknown in Japan. Cows are scarce, and milk and other dairy products are expensive, and such as are available are consumed entirely by the wealthier people in the cities. Professor Oshima says that the peasants in the rural districts of Japan, living largely on vegetable food, are really healthier and stronger than the people of the better classes, who live on a mixed diet.

Among strict vegetarians we also find examples of untiring capacity for work, as, for instance, the people of a Hindoo tribe who carry tourists to the top of the Himalaya Mountains, an ascent of 17,000 feet in three and a half hours. Their food consists of dates, rice, *chapiti* (a food made of chick peas), and a small amount

of butter *(ghee)*. These people are very lean, but are so indefatigable on the march that they allow themselves but a very short time for taking their scanty meals. Despite the cool air in the high altitudes, they go about with little more than a loin cloth.

As previously mentioned, the nutrition diseases, frequently occurring in Oriental countries, are due to a deficiency of the essential organic salts and vitamines in diet, and not to the absence of meat. Wherever the peeled or polished rice is replaced by the natural whole rice, supplemented by green leaf vegetables and vegetable proteins, health is quickly restored.

In all cases where mental and physical endurance have been put to a severe test, it was found that a well selected, meatless diet, shows far better results than a mixed diet, other contributing circumstances being equal. Prize fighters, who are generally heavy meat eaters, decline in health before they reach middle age, whereas the most long lived and healthy people are found among those nations that consume the smallest amount of meat.

Bernard Auzimour, a French army officer, who studied the Arabs for many years, gave the following information about their habits of living in his treatise *La Resistance des Arabes:*

"The Arabs are slim and wiry; their limbs are lithe and strong. They live in tents made of camel's hair, which are of such a nature that the wind blows right through them. Their frugality is just as far famed as that of the camel. Men often go on long journeys into the desert with only a bag of meal, some figs and dates and a skin of water. With the meal the Arab makes some little cakes, each about the size of an ordinary walnut, which he dries in the sun or bakes in his fire. These cakes, with some dried figs or dates, are his provision for the day. The fare is nearly always vegetable plus a little milk, and, very rarely, a little meat.

"Alcohol—the 'sea of sin' as the Arabs call it—is strictly forbidden them by their creed, for their prophet was well aware of its dangerous influence.

"The Arabs are very hardy and very resistant to disease. Abdominal wounds, with perforation of the intestines, heal without the use of antiseptics when the injured parts have been put back into place. Wounds, healing in such circumstances and without consequent blood poisoning, are a source of wonder to surgeons acquainted only with meat-eating Europeans.

"The Arabs are almost entirely immune to typhus. There are many French physicians in Tunis who have never encountered a case of disease among these people. The following statistics from L'Hopital de Mustapha are very striking. It was found

there were 659 cases of typhus among 28,251 European patients, which is 2.3 per cent, and among 9,147 Arab patients there were but thirteen cases of typhus, which is 0.1 per cent.

"According to these figures 23 meat-eating and wine-drinking Europeans developed typhus to one of the abstemious, practically vegetarian Arabs, despite the fact that the former live under far better sanitary conditions.

"Diseases of nutrition are almost unknown; ulcers and cancer of the stomach are very seldom met with, and if one comes across a case of summer diarrhoea, it is generally because the sufferer has been eating too many melons. Appendicitis is very rare among the Arabs, and is entirely unknown among the vegetarian nomads. Gout and kidney gravel are also quite unknown.

"That this immunity against disease is by no means a racial peculiarity is shown by the fact that wherever the wealthier classes of Arabs have adopted European methods of eating, their resistance against diseases is decreasing. This is but natural, as the putrefaction arising from a heavy meat diet is at the root of most intestinal disorders."

In his book "Protein and Nutrition," Dr. M. Hindhede gives some interesting and instructive statistics about mortality in different occupations in England, taken from Tatham's 65th annual Report (1900-1902). For the sake of comparison he puts the ratio of mortality of farm laborers, who as a rule lead a simple and frugal life in the open air, at one per cent, and makes the following divisions:

1. Farm laborers, who are not able to afford much meat as a rule.
2. Workmen in towns, representing the urban lower class.
3. Tradesmen (building trade), representing the urban middle class.
4, 5. Commercial travelers and butchers, representing the heavy-living (meat eating) classes.
6. Physicians, representing the well-to-do intelligent classes.

TATHAM'S 65TH ANNUAL REPORT

	Tuberculosis	Bright's Disease	Diseases of the Liver	Diseases of the Digestive. System	Diabetes	Gout
Farm Laborers	1.00	1.00	1.00	1.00	1.00	1.00
Industrial "	6.30	4.79	5.25	2.09	1.67	1.00
Building Trades	2.11	2.79	2.62	1.20	1.17	3.00
Commercial Travelers	1.87	2.92	7.50	1.40	2.50	4.00
Butchers	2.02	3.23	7.50	1.45	3.33	5.00
Doctors	0.72	3.14	6.75	2.30	4.00	3.00

Dr. Hindhede makes the following comment:

"There are many interesting things to be learned from this table. But one lesson it does not teach. It is not able to persuade us to believe that meat imparts health and energy! *Diseased stomachs, livers and kidneys are not calculated to increase mental power.*" (The italics are mine.)

"As a doctor, I am glad to see how my professional brothers are able to avoid tuberculosis; but it grieves me to see my English colleagues dying of diseases of nutrition at a higher rate, as a rule, than men of other occupations. They appear to have been martyrs to the mistakes of science.

"That meat-eating does not prevent tuberculosis is proven by the fact that the death-rate from tuberculosis is very high among butchers and commercial travelers.

"That deaths from tuberculosis are higher in towns than in the country is easily understood; but it is, according to old views, difficult to understand why the mortality from Bright's disease and from liver and digestion diseases, should be so high in the cities, where people eat 'easily digestible' foods, in contrast to the coarse foods used in the country.

"I have heard many authorities speak about meat as an energy-food, but I have never yet encountered any proof of it. I will not deny that after eating a large beefsteak there may be a feeling of bodily warmth. Meat is able to increase combustion (Rubner), but this feeling is not energy. After such a beefsteak there is more inclination for sleep than for hard work. Meat is a fiercely burning fuel, but it seems to burn out the oven itself in the long run.

"Thus, it will be seen that it is very misleading to write: 'The more energetic races of the world have been meat-eaters.' The truth is that the energetic races eat but little meat; but with increasing wealth and culture, meat-eating also increases, while the national energy decreases. Once the reserve of healthy, plain livers is exhausted (rural populations are at present decreasing) there is nothing to prevent the invasion of some energetic barbarian race, which may conquer and rule for a time until the conquerors also degenerate, spoiled by contact with the two greatest dangers that exist for human beings: wealth and modern culture. Every student of history must know that wealth, gluttony and drunkenness are the three great destroyers of energy."

Another, and perhaps the most important argument, in favor of the vegetarian or fruitarian diet, is that man can derive his nourishment from a much smaller area when living on the products of the soil, for he is receiving them directly from nature, instead of feeding them first to cattle and living on their flesh. As the population of the earth steadily increases, man will have to content

himself with a smaller space on which to raise his food supply. The land that now serves for hunting grounds or cattle raising will be much more economically utilized for the cultivation of fruits, nuts, vegetables and cereals. It has been estimated that an area of well cultivated land can sustain at least twenty times more people by its crops than can be nourished on the meat of cattle that feed on its spontaneous grasses.

The following table shows the average amount of different products now raised on an acre of land. Better cultivation of the soil, combined with proper knowledge and care will in every instance increase the output, while the productivity of tropical soil under systematic cultivation is simply astounding.

Food Products

	Average Yield Per Acre		Water Free Substance	
Bananas	24,000	pounds	6,000	pounds
Avocados (trees in full bearing)	10,000	"	3,000	"
Dates (trees in full bearing)	5,000	"	4,000	"
Cocoanuts (trees in full bearing)	5,000	"	1,500	"
Grapes (vines in full bearing)	8,000	"	2,000	"
Figs (trees in full bearing)	6,000	"	1,200	"
Oranges (trees in full bearing)	14,000	"	1,800	"
Pecans (trees in full bearing)	2,500	"	2,000	"
Chestnuts (trees in full bearing)	2,500	"	2,000	"
Almonds (trees in full bearing)	1,400	"	1,200	"
Walnuts (trees in full bearing)	1,200	"	1,000	"
Corn	1,960	"	1,695	"
Sweet Potatoes	5,940	"	1,782	"
Irish Potatoes	6,000	"	1,500	"
Rye	1,200	"	1,050	"
Wheat	1,200	"	1,050	"
Rice	1,154	"	1,000	"
Soy Beans	960	"	850	"
Peanuts	524	"	500	"
Oats (hulled)	784	"	720	"
Beans	840	"	800	"
Cow Peas	600	"	520	"

Dairy Products

Milk	2,190	pounds	285	pounds
Cheese	219	"	160	"
Butter Fat	98.5	"	90	"

Poultry (raised for meat and eggs)

	Average Yield Per Acre	Water Free Substance
Meat (dressed)	66 pounds	20 pounds
Eggs	110.7 "	80 "
Poultry raised for meat alone	171 "	48 "
Poultry raised for eggs alone	183 "	51 "

Meat

Pork (dressed)	273 pounds	70 pounds
Mutton (dressed)	113 "	30 "
Beef (dressed)	125 "	35 "

Most of the foregoing figures have been prepared by the United States Department of Agriculture. The production of live stock products per acre was calculated by assuming the acre to be devoted to crops suitable for feeding the kind of animal under consideration, and in the proper proportion to give a balanced ration. In cases where it was not practicable to do this because of the necessity of using some food not produced on the farm, it was assumed that a suitable proportion of the acre product was exchanged for whatever else was needed.

It is a surprising fact that in most parts of North America, but especially in the United States (and in portions of Australia and South America) the chief object of agriculture is not to feed men, but to feed animals. The American farmer grows corn and alfalfa, feeds it to cattle, and then in turn eats the cattle; but the ox, used as the standard in the preceding table, ate daily 15.64 pounds of corn; 1.66 pounds of cottonseed meal; 20.5 pounds of corn silage; 2.74 pounds of clover hay, and 7.29 pounds of corn fodder. On such ration a gain of about 2¼ pounds per day is made, and of this a considerable proportion—more than a third—disappears as inedible waste in the process of slaughter. It is safe to assume that the land necessary for feeding one ox could, under intensive cultivation, produce enough fruits and vegetables to support ten people.

The wastefulness of meat production from the standpoint of national resources is well stated by Professor Armsby, a leading authority on animal nutrition:

"It may be roughly estimated that about 24 per cent of the energy of grain is recovered for consumption in pork, about 18 per cent in milk, and only about 3.5 per cent in beef and mutton. In

other words, the farmer who feeds bread grains to his stock, is burning up 75 to 97 per cent of them in order to produce for us a small residue of roast pig; and so is diminishing the total stock of human food.

"At any rate, it is clear that at the present time the enthusiastic but ill considered booming of live stock production may do more harm than good. If it is desirable to prohibit the production of alcohol from grain or potatoes, on the ground that it involves a waste of food value, the same reason calls for a restriction of the burning up of these materials to produce roast pig. This means, of course, a limited meat supply. To some of us this may seem a hardship. Meat, however, is by no means the essential that we have been wont to suppose, and partial deprivation of it is not inconsistent with high bodily efficiency."

We may also briefly consider vegetarianism from a sociological standpoint. Plato in his dialogue, "The Republic," represents Socrates as describing an ideal city whose inhabitants subsist on a simple vegetarian dietary. Glaukon objects to the simplicity of the fare and Socrates replies as follows:

" 'Now it appears to me that the city which we have described is the genuine, and, so to speak, healthy city. But if you wish us also to contemplate a city that is suffering from inflammation, there is nothing to hinder us. Some people will not be satisfied, it seems, with the fare or the mode of life which we have described, but must have, in addition, couches and tables and every other article of furniture, as well as viands . . . . Swineherds again are among the additions we shall require—a class of persons not to be found, because not wanted, in our healthy city, but needed among the rest of the addition. We shall also need great quantities of all kinds of cattle for those who wish to eat them, shall we not?'

" 'Of course we shall,' replies Glaukon.

" 'Then shall we not experience the need of medical men also to a much greater extent under this than under the former regime?'

" 'Yes, indeed.'

" 'The country, too, I presume, which was formerly adequate to the support of all its inhabitants, will be now too small, and adequate no longer. Shall we say so?'

" 'Certainly.'

" 'Then must we not cut ourselves a slice of our neighbors' territory, if we are to have land enough for both pasture and tillage; while they will do the same to ours, if they, like us, permit themselves to overstep the limit of necessaries and plunge into the unbounded acquisition of wealth?'

" 'It must be inevitably so, Socrates.'

" 'Will our next step be to go to war, Glaukon, or how will it be?'

" 'As you say.' "

It will be observed that, over two thousand years ago, one of the greatest philosophers clearly saw the evil and far-reaching effects of flesh eating. And yet there are even now comparatively few people who realize that the degeneration of man is largely the outcome of perverted dietetic and hygienic habits, and that the slaughter-house is a never ending source of immorality, brutality and crime. As a matter of fact, it is impossible for a man to remain a criminal after he has once begun to live in perfect harmony with nature, which is the only way to restore harmony within himself and amiable relationship with his fellowmen.

The perverted sexual instincts of man and the dreadful maladies for which they are responsible are likewise but the consequences of his unnatural methods of living. Despite the numerous books that have been written on this important subject, and all the well meaning information that they may contain, thousands still suffer from these most fatal violations of nature's laws, making not only their own lives, but also those of their children, a hopeless fight with misery and disease.

The ethical aspect of vegetarianism is beautifully elucidated by one of America's most famous authors and naturalists, Henry David Thoreau. He says in his book "Walden" in the chapter "Higher Laws":

"I believe that every man who has ever been earnest to preserve his higher or poetic faculties in the best condition has been particularly inclined to abstain from animal food, and from much food of any kind. . . . . .

"It is hard to provide so simple and clean a diet as will not offend the imagination; but this, I think, is to be fed when we feed the body; they should both sit down at the same table. Yet perhaps this may be done. The fruits eaten temperately need not make us ashamed of our appetites, nor interrupt the worthiest pursuits. But put an extra condiment into your dish, and it will poison you. It is not worth the while to live by rich cookery. Most men would feel shame if caught preparing with their own hands precisely such a dinner, whether of animal or vegetable food, as is every day prepared for them by others. Yet till this is otherwise we are not civilized, and, if gentlemen and ladies, are not true men and women. This certainly suggests what change is to

be made. It may be vain to ask why the imagination will not be reconciled to flesh and fat. I am satisfied that it is not. Is it not a reproach that man is a carnivorous animal? True, he can and does live, in a great measure, by preying on other animals; but this is a miserable way—as anyone who will go to snaring rabbits, or slaughtering lambs, may learn—and he will be regarded as a benefactor of his race who shall teach man to confine himself to a more innocent diet. Whatever my own practice may be, I have no doubt that it is a part of the destiny of the human race, in its gradual improvement, to leave off eating animals, as surely as the savage tribes have left off eating each other when they came in contact with the more civilized."

CHAPTER VIII

Dehydration of Foods

Ever since man began agriculture in the temperate zones, even before the dawn of written language, the preservation of food products for the winter months, or for the purpose of providing nourishment during periods of famine, has been a very important problem. The various grains and nuts offered but little difficulty in this respect, as they were already fairly well dried by the sun when harvested. Throughout the arid sub-tropical regions, such fruits as grapes, figs, and dates could be easily preserved by exposing them to the rays of the sun as is still done today.

Sun drying is probably the oldest method of food preservation which the human race employed. On the North American Continent it was used in the early colonial days for both vegetable and animal foods. New England colonists dried corn after it had been cooked, the product being known as *samp,* while along the coast the drying of fish became an important industry. It is only since the beginning of the nineteenth century that the canning of foods was introduced in Europe and the Western Hemisphere. The first patent for the preservation of food in air-tight containers was granted in 1910 to a Frenchman, Appert, who discovered the method and first utilized it in France.

Food canning was first introduced in America by William Underwood, who established a company for the exploitation of his process in Boston. Canned goods, especially after the introduction of tin cans, soon became popular, and canning, in many places, superseded the simpler process of drying. The Civil War gave an added impetus to the canning industry, and later improvements in the methods of sterilization and in the manufacture of cans greatly increased the possibilities of canning, until we have now an enormous industry. In 1922, in California alone, 500,000,000 cans of fruits and vegetables were packed and are now being distributed throughout the entire world. California canners are packing approximately 20,000 carloads worth $125,000,000 annually.

At the same time, there has also been a tremendous development

in methods of preserving foods by *cold storage,* and other means such as *pasteurization, condensation,* etc. Although these processes require a large investment of capital and elaborate machinery, the less expensive process of drying was practically forgotten, except in the interior valleys of California, where fruits could be dried in a comparatively moisture free atmosphere.

Drying of foods was revived again in the United States after the discovery of gold in Alaska in 1896. The rush of miners to the Klondike districts created a demand for foods which were light and could be easily transported. At that time considerable quantities of dried potatoes were imported from Germany and shipped to Alaska, and while they were not very palatable, they supplied a quickly prepared, energy-giving ration. The migration to the Alaskan goldfields also encouraged the drying of vegetables along the Pacific Coast, and many crude evaporating plants were built to supply demand for foods which contained a good deal of nourishment in a condensed form, suitable for transportation over the snow covered mountains.

The Boer War likewise stimulated the drying industry in western Canada, and the British Army was supplied with many tons of dried vegetables mixed so as to form the basis for a quickly prepared soup. Much of this material was manufactured in British Columbia and shipped from Canadian and American points to South Africa.

The advantage of evaporated vegetables and fruits as compared with the heavy canned goods, in reducing the cost of production and transportation, caused the establishment of a number of small plants for the manufacture of dehydrated vegetables and so-called soup mixtures. At first these products were not satisfactory, but the soundness of the principles involved was soon recognized, and more scientific methods were gradually applied and many details perfected.

Again, the World War brought an increasing demand for dried vegetables and thousands of tons were shipped to Europe. In Germany where the potato is the great staple food, the progress of the drying industry has been more rapid than elsewhere. In 1898 there were in Germany only three small drying plants with a capacity scarcely large enough to be worthy of mention. The method of dehydration then used was evidently successful, for in

1906 the number of plants had increased to 39, in 1909 to 199, and in 1916 to 841. In addition, 2,000 breweries were utilizing a part of their equipment for the drying of food materials. So rapid was the increase of this industry on account of the food blockade, that about 1900 drying plants were either in operation or under construction in 1917. The fact that the total quantity of potatoes dried in Germany alone was more than three times the total crop of the United States, explains one of the reasons why Germany could hold out so long in her desperate struggle, when all food supplies from the outside were practically cut off.

In France as early as 1850 a great number of vegetables and fruits were subjected to hydraulic pressure, producing a highly concentrated food product. Somewhat similar mixtures of green leaf vegetables and legumes were used in the German army during the Franco-Prussian War in 1870.

In the United States the industry of drying food products did not assume any large proportions until the beginning of the World War. After the first year of the war, it was found impossible to supply fresh and canned vegetables in adequate quantities to the British forces, and those of the Colonies. Canada and the United States, therefore, were called upon to furnish dehydrated vegetables in very large quantities. To supply this demand the owners of the already established apple kiln dryers in New York and Pennsylvania took up the drying of vegetables, but as little was known of the proper methods of preparation and drying, much of the finished product was of poor quality.

After the United States entered into the World War, the demand for dried fruits and vegetables increased still more, and, when the first American troops landed in France, several large orders for dried food products were placed with the numerous evaporating plants, which had just been established.

The United States Department of Agriculture detailed chemists and food experts to aid in investigations for the benefit of the industry, and a number of experimental stations were established and the study of scientific dehydration of fruits and vegetables was begun. As a result of these efforts, much progress was made in the practical knowledge of the best methods to prepare foods, of temperatures of drying, and air and humidity control. While the

evaporation of apples and berries has long been an established industry in certain sections of the United States, especially in western New York, and the evaporation of prunes has been an important business in the Pacific Northwest since 1890, it was only with the rapid increase of the California fruit industry that dried fruits of the Pacific Coast became an important factor in the world's commerce.

From small beginnings, the production of dried fruits in California has grown enormously during the last twenty years, especially since the growers have organized for the packing and distribution of their products and new markets have been opened.

The total production of dried fruits rose from approximately 185,000 tons in 1910 to approximately 360,000 tons in 1920. Since then, orchard and vineyard acreage has increased rapidly. In 1919 and 1920 alone about 275,000 acres were planted, and nurseries were unable to supply the demand for trees and vines. We should therefore expect a very much increased output of fruit by 1925, when most of the newly planted orchards and vineyards come into bearing.

The difficulty of shipping fresh fruit to great distances and the frequent car shortage through the harvest season, must necessitate a larger production of dried fruits, as it will be almost impossible for the canneries to take care of an increase over 100,000 tons of fresh fruit. The markets and the consumption of dried fruits, must also be increased, if fruit growing is to continue to be profitable. This can be done by improving the quality of dried fruits, doing away with all the objectionable features of the old fashioned drying processes and by educating the public to the great nutritive and hygienic value of properly dried fruits.

Except for a few years at the beginning of the California fruit industry, nearly all fruits have been dried in the sun, especially in the hot and dry interior valleys where the conditions for sun drying are excellent. One of the most objectionable adjuncts of sun drying is the sulphuring of such fruits as apricots, figs, nectarines, peaches, pears, silver prunes, etc., to prevent their discoloration while exposed for a week or more to the open air.

Under the able guidance of Professors W. V. Cruess and A. W. Christie of the Agricultural Experiment Station of the University of California in Berkeley, methods of dehydration have been im-

proved recently and much credit is due them for the fact that scientific methods of foods preservation have become better understood throughout the Pacific Coast regions. The University of California has published their investigations and experiments in a number of bulletins, which show that properly dehydrated products are equal or even superior to the sun dried fruits, and that dehydration possesses many advantages over sun drying, both from the sanitary and the economical point of view, with the exception of the California raisin and fig, as the curing of these fruits in the dry and hot climate of the San Joaquin Valley has proved satisfactory.

It is only during unusual climatic conditions, such as early fall rains, that the artificial drying of raisins has to be resorted to. This was the case in 1918 when, in the first part of September, a heavy rainstorm lasting several days drenched California and ruined millions of dollars worth of fruit, lying on trays in the orchards, throughout the leading fruit districts. This unfortunate occurrence caused the erection of many improvised evaporators, to save as much as possible of the fruit crop intended for drying. But this great and sudden loss of a year's effort and toil brought the subject of dehydration of fruits even more forcibly to the front than the war.

So far, the terms "drying" "evaporating" "dehydrating," have been used more or less indiscriminately. In 1920 Professors Cruess and Christie published their views upon the terminology of fruit drying processes in Agricultural Bulletin No. 322 of the University of California. At that time it was stated that the term "dried" should apply to all dried fruits, whether sun dried or dried by artificial heat, and that "evaporated" should be used to designate fruits dried by artificial heat. "Dehydrated" and "evaporated" have exactly the same meaning, only one is derived from the Latin and the other from the Greek. The fruit-drying industry itself, however, has definitely favored the word "dehydrated" in preference to "evaporated" to designate artificially dried food products of superior quality. It appears, therefore, that commercial usage may cause the adoption of the former term in the dried fruit trade.

In order to avoid confusion, the following definitions are now generally used.

1. Drier: A general term, applicable to all machines used for drying fruits or other materials. Examples: hot drier, cement drier, lumber drier, etc.

2. Evaporator: A drying machine without any forced draft which does not permit accurate control of temperature, humidity, or air velocity.

3. Dehydrater: A drying machine with forced draft and in which the temperature, relative humidity, and air velocity can be accurately controlled.

The advantages claimed for the process of dehydration are:

1. That the dehydrated fruits, when prepared for the table, more nearly resemble the fresh fruit in color and flavor.

2. That dehydrated fruits are produced under more sanitary conditions.

3. That dehydration permits more exact control of quality and yield.

4. That less land and fewer trays are required to dehydrate a given tonnage of fruit.

5. That dehydration makes it possible to combine all the steps of drying and packing in one building.

Besides providing against rain damage, dehydraters are useful in fruit-growing sections in which there is, even in normal years, insufficient sunshine to permit successful sun drying.

The evolution of the modern process of dehydrating from the earliest kiln driers to the present highly efficient system, is a record of one attempt after another to secure air circulation upon which the effectiveness of the drying process depends.

In the further development of drying processes from natural or gravity circulation, by convection, to mechanically forced circulation by means of fans or blowers, it became apparent that the moisture content of the air, and its vapor pressure, as well as the temperature, must be carefully studied and controlled. The circulation of the air must not only be uniform throughout the entire interior of the dryer, but the velocity of such circulation must be high enough to insure effective action. This relatively high velocity is

necessary, because the material, as soon as it begins to dry, becomes surrounded with a heavy, sluggish strata of saturated air and the velocity of impact of the air in circulation within the drier must be sufficient to constantly disperse this air.

Fruits and vegetables cannot be dehydrated satisfactorily in very dry air, and in order to process them successfully, we must surround them with moist air. To the uninitiated it may seem paradoxical, that in order to make fresh foods dry, we must surround them with moist air, which will dry them quickly and uniformly, whereas dry air will not dry them at all, or at least very poorly.

In dehydrating, the temperatures used vary, usually from 75 degrees to 180 degrees F. and the relative humidity from 15 per cent to 80 per cent. As the temperature increases, the moisture carrying capacity also increases, but at a much faster ratio. This is indicated by the following table, showing how much moisture air at a given temperature can absorb to bring it to the point of saturation or 100 per cent relative humidity.

	Grains of moisture in 1 cubic foot of air at point of saturation:
70 Degrees of Fahrenheit to	7.94
85 " " " "	12.43
105 " " " "	22.00
110 " " " "	25.00
115 " " " "	30.00
130 " " " "	42.50
141 " " " "	58.00
157 " " " "	85.00
170 " " " "	112.00
179 " " " "	138.00
188 " " " "	166.00
195 " " " "	194.00
212 " " " "	265.00

(Weight of 1 cubic foot of air approximately 550 grains or 1¼ oz.)

At 141 degrees F. the moisture carrying capacity of the air is more than seven times greater than at 70 degrees F., while at 170 degrees F. it is 14 times greater than at 70 degrees F.; in other words, a rise in temperature of 100 degrees, has increased the moisture carrying capacity of the air fourteen times. 1,000 cubic feet of air at 170 degrees F. can carry 16 pounds of moisture, or about ⅕ of the weight of the air.

The expansion of air with increasing temperature is very small,

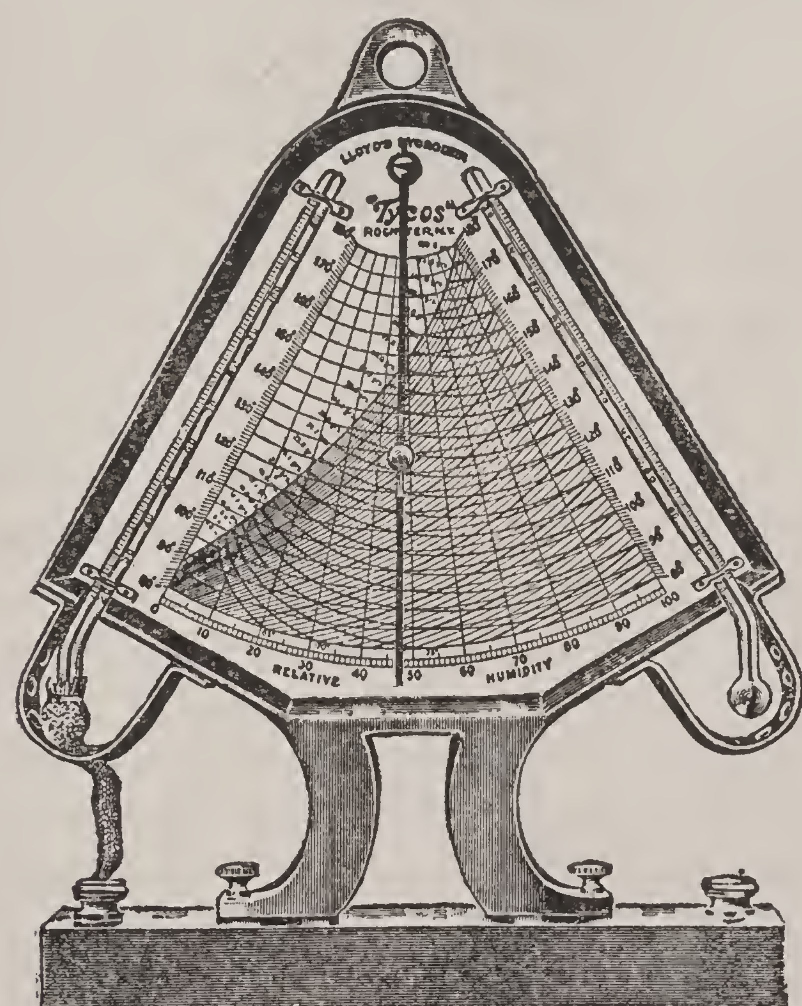
amounting to only 1/490th of the volume for each degree in the rise of temperature; while the amount of water vapor which can be absorbed is practically doubled at each 27 degrees F. rise in temperature. At the beginning of the dehydrating process when the free, or non-hygroscopic moisture is being removed, the relative humidity is comparatively high, usually 80 per cent or more. This high relative humidity must be maintained in order to prevent the material from "case-hardening" or surface-drying. Surface drying causes surface ruptures and spoils the product. Furthermore, surface-drying encases the fruit in a layer of dried material through which it is difficult, and sometimes practically impossible to induce further drying. At a relative humidity of about 80 per cent most hygroscopic substances possess their maximum elasticity or plasticity, and this is, therefore, the relative humidity most desirable at the beginning of the process.

Rapid heating in dry air of freshly cut slices of a succulent fruit or vegetable causes bursting of the cell membranes by expansion of their contents and permits the escape of water, which carries with it dissolved sugars, organic salts, and flavoring substances, thus reducing both the palatability and the food value of the product. Consequently, only moderate temperatures can be employed at the beginning of the drying process, otherwise bursting of cells and dripping will occur. It is evident, therefore, that rapid drying cannot be secured by the employment of high temperatures with fresh fruits or vegetables, without depreciating the quality. Nor can materials already partially dry be subjected to high temperatures without injuring the products or making them almost valueless from the standpoint of rational nutrition.

After the free moisture has been absorbed and carried off, it is best to retain only part of the hygroscopic moisture, because the removal of all this moisture usually effects a physical change in the material which reduces its value. The regulation of the final or residual hygroscopic moisture content is accomplished by maintaining in the dehydrater, at the end of the process, such a degree of relative humidity as corresponds with the final moisture content desired in the finished product. For instance, if evaporated fruits with 20 per cent moisture are wanted, the relative humidity at the end of the dehydrater should show approximately the same percentage.

Successful dehydrating depends upon proper arrangements for preventing the series of changes which begin as soon as the material is cut into pieces and exposed to the air. This entails the employment of a temperature high enough to prevent the growth of micro-organisms, but not too high to cause bursting of the cells in the fresh material or the scorching of the parts which have lost most of their water.

Fruits and vegetables are composed of millions of cells filled with water and surrounded by a network of delicate fiber and connecting tissue. If the water is removed from the cells without damaging the cell walls or the surrounding fiber, the cells will retain their elasticity and absorb moisture again at the first opportunity. This can be best accomplished by first subjecting the fruit to a current of humid air of moderate heat and gradually increasing the temperature until the fruit has lost about fifty per cent of its moisture.



A Convenient and Accurate Form of Hygrometer for the Determination of the Relative Humidity of Air in Dehydraters

The hygrometer is a very necessary instrument for the proper control of the moisture content of the air, which has been shown

to be one of the most impotant factors in the correct dehydration of fruits. It is a simple instrument, and anyone can easily operate it after a few minutes' instruction. It indicates the absolute and relative humidity of the air.

Absolute Humidity is the actual weight of water vapor contained in a given amount of air, the weight being expressed in grains per cubic foot of air.

Relative Humidity, on the other hand, is the ratio of the amount of moisture in the air to the amount contained when saturated at the same temperature. It is, therefore, expressed in per cent.

The ordinary temperature of the air, without any relation to its moisture content, is known as the *dry bulb* temperature. The *wet bulb* temperature, read on a thermometer having its bulb wound with a moistened wick, is the temperature at which the air would become saturated if moisture were added to it without the addition or subtraction of any degree of heat.

The difference between the wet and dry bulb temperature is a measure of the amount of moisture in the air. The humidity of the air is determined by this relation; the humidity being read from the chart on the hygrometer.

In the old style evaporators, very little attention is paid to the moisture content of the air. The chief use of the kiln evaporator in New York, Pennsylvania, Missouri, and Virginia, is for drying sliced apples. The drying room of a kiln has a floor made of narrow pieces of slate laid at intervals of one-fourth or three-eighths of an inch apart, and the fruit to be dried is spread upon the floor in a uniform layer of four to six inches in depth. The heat is furnished by pipes from a furnace below.

The tunnel evaporator, as generally used for prunes in Oregon, Washington, and Idaho, has been gradually perfected by modifying the "Allen Evaporator," manufactured and patented by W. K. Allen of Newberg, Oregon. In its essential feature this tunnel evaporator consists of a long narrow room, with the floor and ceiling inclined uniformly from end to end, and with a furnace below the floor. The room is cut into a series of narrow chambers or "tunnels," by parallel partitions, which may be solid or merely an open frame work of slats. In some of the larger and more elaborate plants the trays upon which the fruit is spread are loaded upon trucks fitted with an open framework to support and separate

them, and these trucks are rolled in one behind another at the upper end of the tunnel until it is filled. The dry fruit is removed at the lower end by withdrawing the truck carrying it, and then the others are moved down by force of gravity, permitting a new truck to be rolled in at the upper end.

The heated air is admitted at the lower end of the tunnel from a furnace placed in the room beneath, and rises through the successive series of trays, and then passes off, loaded with moisture through a ventilator shaft at the opposite, higher end. The air-movement is secured by an arrangement of air intakes in the fire room.

The Stack Evaporator is used commonly in California for apple drying. The heating system is the same as that used for the kiln and tunnel operators. The drying cabinets or "stacks" are on the second floor. The drying takes place on trays which slide into a drying chamber situated directly above the heating flues. The bottom of the stack is open; the top consists of an inverted hopper which ends in a tall ventilator.

Like the kiln drier and the Oregon tunnel evaporator, this stack evaporator has no forced draft or humidity control, and consequently does not turn out the highest quality of evaporated fruit.

The Air Blast Evaporator if properly operated, is a vast improvement over the Oregon Tunnel Evaporator. It is now used by many California fruit growers as a matter of crop insurance. This evaporator consists of a long horizontal, or nearly horizontal chamber or tunnel, in which the fruit is placed for drying. A fan blows or draws air through a heating system at one end of the tunnel and forces the heated air through the drying chamber. The fan may be of the positive blower type, in which case the air heater and the fan are located at the same end of the evaporator; or it may be the exhaust or suction type, in which case the air is drawn through the evaporator and the air heating system is located at the end opposite the fan. The exhaust fan is believed to produce a more uniform current of air throughout the length of the evaporator. Ventilators as a rule are connected with the tunnels to regulate the flow of air, also to permit the whole or partial re-circulation of the air, as this helps to regulate temperature and moisture, especially at the beginning of the process. Re-circulation of a large part of the air in the drying, conserves fuel and makes possible the regula-

tion of the humidity of the air, which is a factor of great importance in fruits which tend to case-harden. Under average conditions, from five to eight times as much air is required for heat transfer as for moisture removal. It is often possible to return as much as 75 per cent of the air to the heating chamber. Re-circulation has been successfully used in many dehydraters since 1920.

The air heating system is often composed of steam coils over which the air is drawn or blown by a fan. The temperature of the air can be closely regulated by controlling the pressure or the amount of steam used. Another system in common use consists of a furnace and large flues enclosed in a fire-proof room, through which the air is drawn by a fan. This type of construction is cheaper than that employing steam coils, but the steam-heating system has certain advantages, as the heat can be distributed more evenly in the tunnels by means of steam pipes.

Vacuum Evaporators are used in drying certain chemicals and substances easily injured by heat or air. Under a vacuum, evaporation goes on at a lower temperature than under normal atmospheric pressure; fruit can be evaporated very rapidly at 100° F. in a vacuum evaporator. Oxidation by air, which takes place in ordinary evaporators, is very greatly reduced by this process; and consequently, a product of fresh flavor and appearance is made possible. This type of evaporator is not in general use because of the high cost of installation and the greater skill and experience that are necessary for its successful operation.

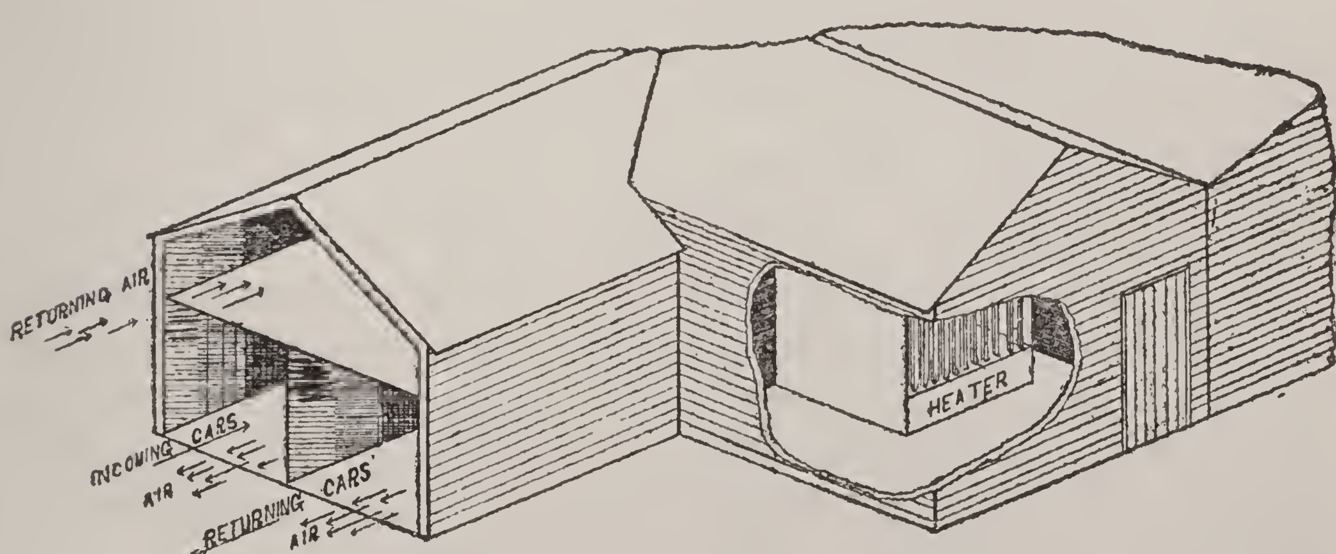
The improved air blast tunnel dehydrater is the most practical and economical for fruit drying now used. In the process of dehydrating, two different systems of operation are generally utilized.

In the so-called "counter current system," the fruit is introduced into moderately warm moist air (100° F. to 130° F.) and moved toward a region of warmer, drier air until the dryness is completed at 160° F. to 180° F. This system has its disadvantages, because, in finishing fruit with a low moisture content at a high temperature, there is danger of caramelizing the sugars. For example, prunes and pears can be subjected to high temperature, when they still contain from 45 to 50 per cent of moisture, but when the moisture approaches within 20 per cent

or less of the finished prunes the temperature cannot be safely over 150° F.

In the so-called "parallel current system," the fruit enters the air intake end of the drying compartment and is taken from the dehydrater at the air exhaust end. In other words, the drying process is started in hot, dry air and is completed in warm moist air. The advantages of this system are found in the possibility of finishing the fruit at a low temperature (approximately 150°F) to obtain a high degree of dehydrating efficiency without injury to the fruit. But this would mean that the temperature at the intake of the tunnel is 185° F. to 190° F., there being a fall of from 35 to 40 degrees in temperature of the air as it passes through the tunnel, due to the heat given off to the fruit and the absorption of moisture. This system works better in dehydrating small fruits like grapes, cherries, sliced or cubed apples, than prunes, apricots, pears and peaches. Prunes, especially, cannot be safely introduced at the high-temperature end of the tunnel if efficiency in drying is desired. If the cool fruit is suddenly subjected to a high temperature, the skin is hardened and rendered less permeable by the moisture from within, a circumstance which greatly retards evaporation.

Charles C. Moore of San Francisco, formerly with the U. S. Department of Agriculture, has combined the two systems in the Duplex Tunnel System, taking advantage of the good features in each, while avoiding their disadvantages.



Duplex Tunnel Dehydrater Designed by C. C. Moore

The Duplex-Tunnel Dehydrater is simply a double-tunnel drier in which the hot air blast moves in the same direction in

each tunnel, with an arrangement for transferring the cars of fruit from one tunnel to the other when at the high-temperature end of the drier. The cars of fruit are entered at the low-temperature end of one of the tunnels and moved toward the air blast, which is in effect, the "counter current system." And when these same cars come to the high temperature end of the drier, while the fruit has yet a moisture content of about 50 per cent, they are transferred to the adjoining tunnel, and returning through it, are moved toward the hot air blast and then toward the low-temperature end of the drier, as in the "parallel-current system."

In the Duplex-Tunnel system, the air is saturated with moisture in the in-going tunnel because the air flow is adjusted to provide for a complete saturation in this tunnel; the adjustable deflector, that divides the air blast as it leaves the blower, being set in a position to allow more air to go into one tunnel than goes into the other.

This principle of circulating the cars of fruit toward and away from the high-temperature end of the drier, means that the Duplex-Tunnel system admits the use of a higher temperature than can be employed, with safety, in any other tunnel system; and a basic principle in dehydration is that the higher the temperature that can be safely used, the more economical is the operation, in respect to fuel consumption, per ton of fruit.

In the Duplex-Tunnel system there is a larger percentage of the air recirculated than in any other system. This is due to the initial high temperature that is used, and to the saturation of the air in the tunnels, which may be as long as eighty feet. The cars loaded with fruit are moved by an endless cable operated by motor power and controlled by a lever at the entrance of the drier. By means of this cable, the cars are moved forward, transferred from one tunnel to the other, and brought back into the second tunnel; this brings a car of finished fruit from the drier at proper intervals of time, the intervals being at the rate of the drying period for a car of fruit. The operating expense per ton of fruit is no more than the cost of sun-drying the fruit, with the advantage of making fruit drying independent of weather conditions, thus saving the fruit grower a great deal of worry and loss.

The following illustration shows a small dehydrater constructed by the author, for the purpose of dehydrating small quantities of fruit and nuts for making nut butters, without subjecting them to a high temperature. The air can be recirculated wholly or partly and the temperature and moisture content regulated. The cost of operation is small. This dehydrater which can hold as much as 500 pounds of fresh fruit is suitable for small fruit farms where the growers want to preserve fruits and vegetables for their own use.

Although the sun-drying of fruits is a large and well-established industry in California, it is apparent to all who have seriously considered the matter, that dehydration offers a means of producing inexpensive dried fruits of new forms and in many cases of better quality than the usual sundried fruits. That this fact is being realized now by the fruit growers is shown by the increase of the dehydrating industry. In California alone over 200 dehydraters of various designs have been built since 1918.

The time required for dehydrating fruits is only a small fraction of that required for sun-drying. Most of the fruits can be dehydrated in from eight to thirty hours, according to kind and size, while sun-drying requires from one to two weeks and often more, if weather conditions are unfavorable.

Another great advantage of dehydration becomes apparent when it is compared with other methods of food preparation, such as canning and refrigeration. Not only can dehydrated fruits be produced and sold at a lower price than an equivalent quantity of canned fruits, but the great decrease in bulk and weight effects a tremendous saving in containers and warehouse charges.

The difference between canned fruits, and dehydrated fruits, both from an economic and hygienic point of view, is seldom realized. For instance, a can of apricots retailing at 25 cents contains one pound of fruit and twelve ounces of syrup made from refined sugar. One pound of the best dehydrated apricots requires nearly seven pounds of fresh fruit and retails for about fifty cents. It furnishes, therefore, almost as much nutritive value as seven cans of apricots. The syrup, which is added in canned fruits contains about equal parts of refined sugar and water and is devoid of organic salts and vitamins, and adds nothing to the hygienic value of the fruit, but rather detracts from it. The proc-

ess of sterilization disorganizes a part of the organic salts and destroys some of the vitamins.

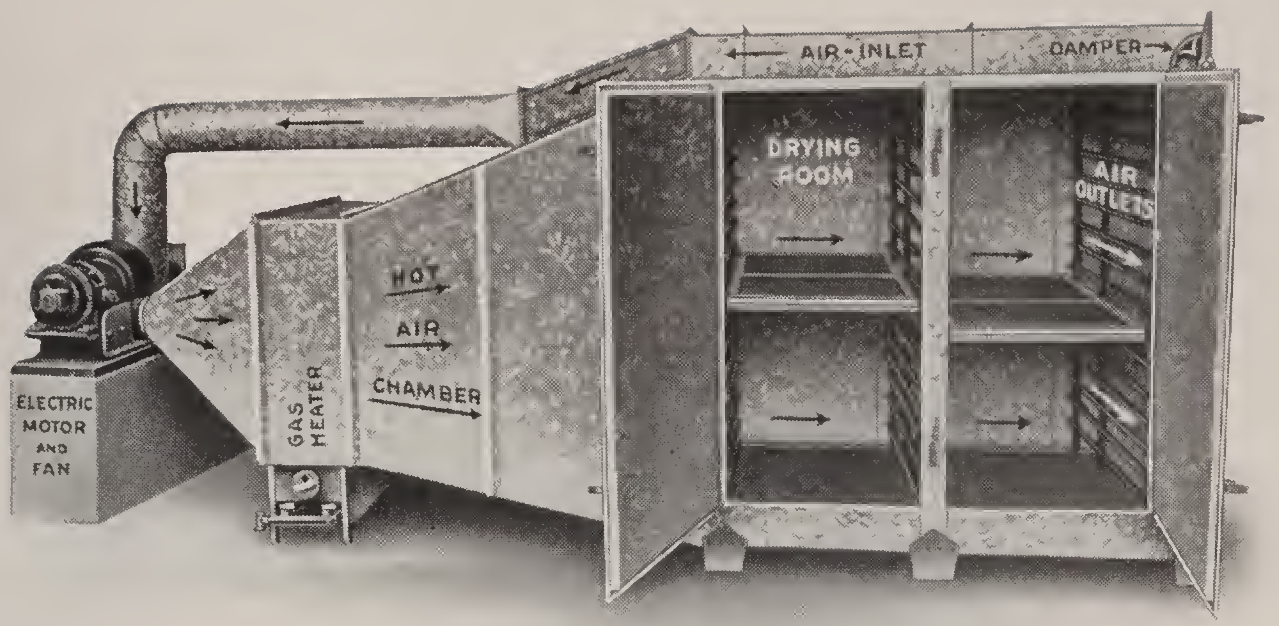
In six cans of apricots, exclusive of the syrup, there is no more real food value than in one pound of dehydrated apricots. Besides, the consumer has to pay for the cost of the syrup and canning, and also for the increased cost of transportation.

Fruits and vegetables contain from 65 to 95 per cent water, which is increased by the liquid added in the canning process. One ton of apricots canned and cased weighs about 3,500 pounds, while a ton of apricots dehydrated and packed weights only 350 pounds. In other words canned apricots weigh ten times more than the same quantity of dehydrated apricots. The same ratio applies to most of the varieties of canned fruit. The great reduction in weight of dehydrated food products is of special importance in California because of its distance from both eastern and foreign markets.

Despite these obvious advantages of dehydrated products, their sale is still restricted on account of their unattractive appearance and inferior quality, often the result of overheating. However, with the knowledge of scientific dehydration, food products can be made as attractive as the sundried article. Properly packed dehydrated products will keep well for years and are not susceptible to the spoilage, sometimes poisonous in nature, which occasionally occurs in canned and refrigerated foods.

The greatest advantage of modern dehydration appears in the stabilization of crops and the conservation of food products. Under the present economic system, the farmer is frequently confronted with either a surplus or a famine. In years of plentiful crops the prices are low and there is not enough demand for the products. By proper dehydration the excess of the years of plenty can be stored up and sold later, when market conditions have improved.

Dehydration reduces fresh vegetables and fruits from one fifth to one tenth of their original weight, and from one third to one half of their original bulk. Dehydration also solves the problem of procuring inexpensive containers, for dehydrated products keep well in paraffined or parchment-lined pasteboard cartons, that is, if they are packed as soon as possible after they come from the dehydrator to prevent infection by insects. The following



SMALL MODERN DEHYDRATER, DESIGNED BY THE AUTHOR

Built of galvanized sheet iron and insulated by asbestos. Capacity, thirty trays; size, 24x36 inches; holding about 500 lbs. fresh fruit. Heated by means of a gas radiator. Distribution and recirculation of air carried on by means of a multiple fan, driven by ¾ horse-power electric motor.

THE "PROGRESSIVE EVAPORATOR," now successfully used in the leading fruit growing districts of California, is an improved tunnel type plant with perfect regulation of temperature, air flow and humidity.

table furnished by Professor Caldwell shows the yields of dehydrated products per hundred pounds of fresh material.

Apples, late autumn and winter varieties	12	to 15	lbs.
Apples, summer varieties	10	to 12	"
Apricots	16	to 18	"
Blackberries	16	to 20	"
Beets	14	to 17	"
Cabbage	8	to 9	"
Carrots	10	to 12	"
Celery	8	to 9	"
Cherries, pie	17	to 21	"
Cherries, sweet	22	to 26	"
Corn, sweet	22	to 33	"
Figs	18	to 23	"
Logan blackberries	17	to 22	lbs.
Onions	9	to 11	"
Parsnips	20	to 22	"
Peaches	13	to 16	"
Pears	18	to 22	"
Peas, garden (mature)	22	to 25	"
Potatoes, sweet	30	to 35	"
Potatoes, white	20	to 23	"
Prunes	30	to 33	"
Pumpkin	6	to 8	"
Raspberries	17	to 23	"
Squash	7	to 9	"
Tomatoes	6½	to 9	"
Turnips	7	to 8	"

Dehydration will also be a most important factor in the conservation of foods. It is estimated that over fifty per cent of the fruit and vegetables grown in the United States never reach the consumer, because of inadequate shipping facilities. It is reported, for instance, that in 1911 approximately 750,000 bushels of apples were wasted in the orchards of Oregon and Washington; and these could have been saved by dehydration. Frequently thousands of tons of vegetables are destroyed in order to keep up the price. There is no reason why these materials should not be preserved by drying, thus making them available as human food. This destruction of surplus products is especially lamentable when millions are suffering for want of proper food.

Furthermore, dehydration will make it possible for the farmer to grow a better diversity of crops, and consequently there will be a good variety of the dehydrated vegetables and fruit, which are nearly equal in value to fresh foods, available to all classes of people throughout the year.

Dehydration will also make the products of the tropics more accessible. Dehydrated bananas found much favor and a ready market in Central Europe under the name of *banana figs*. In fact, the demand exceeded the supply so long as the right quality was produced. If a perfect product is desired, selection of the

right material is of the utmost importance. The small sweet bananas are best suited for dehydration. They must be allowed to ripen thoroughly in the storage room until they have turned to golden yellow color. This is necessary as various layers of the same bunch ripen at different times. It is also important that bananas are picked at the right time and are not bruised. Overripe or unripe bananas will produce a poorly finished product.

Copra, which is the commercial name for dried or dehydrated cocoanut, is already a great article of export from South America, the South Sea Islands, the Philippines and East India, and there is no reason why scientific dehydration and proper protection against insects should not bring many delicious tropical fruits within the reach of the inhabitants of the temperate zones, especially since transportation facilities by means of fast steamers have also been improved.

There is no doubt that dehydration, if done carefully according to well-established principles, is the best method of food conservation, and, while dehydrated foods may not be equal in all particulars to fresh foods, they help to round out man's dietary at times when the latter are not procurable.

CHAPTER IX

The New Agriculture

Before the World War it was generally assumed that, because of our extended areas of agriculture and improved means of production and distribution, the world was practically immune from famine. Despite this belief, in the winter of 1921 twenty million human beings were dying of starvation in the Volga district. Within the last few years famine, war and disease have reduced the population of Armenia from six millions to two millions; the city of Petrograd, from two millions to three-quarters of a million; Poland has lost half her population, while a hundred million Chinese have suffered for lack of food. During the first quarter of the twentieth century, throughout Europe and Asia more than three hundred million people have approached the point of starvation.

Is it not rather strange that in a world where within a generation man has learned to talk on waves of ether through 10,000 miles of space; to harness the power of air and water; to measure and analyze the stars a million light-years away, the leading authorities of the world's universities have not yet advanced beyond the speculative period concerning how to protect mankind against famine?

Up to the present time man has scarcely begun to utilize the tremendous treasures stored in the deeper layers of the earth's sub-soil. Most of the arable land is devoted to the superficial culture of cereals, and in some countries, like the United States and Canada, by far the largest portion of the cultivated area is used not to feed man, but cattle. It has been shown in another chapter how costly and wasteful it is to live on the meat of animals which we have to feed, instead of deriving our sustenance directly from the products of the soil; and how, in the long run, the cultivation of cereals for human food alone is less profitable than scientific fruit culture.

Eighty per cent of all cereals raised are needed for the maintenance of live stock. Even in densely populated Germany 70 per cent of all the land under tillage is devoted to raising cereals; about

15 per cent to potatoes; 12 per cent to other kinds of vegetables, and only 3 per cent to fruit culture. In Great Britain, of the total area under tillage, cereals constitute 67 per cent; vegetables and legumes, 26 per cent; potatoes, 5 per cent, and fruit culture only 2 per cent. In addition, these two countries have a very large proportion of their acreage in grass used for pasture grounds. Even now, in the United States, after the displacement of a large number of farm animals by the automobile, the cultivation of fruit trees does not cover over two per cent of the area that is given over to the raising of cereals.

Japan with an average population of 350 people per square mile is perhaps the best example of a country that has developed its agricultural resources, utilizing every arable acre. On an average, about five people, or a medium-sized family, gain their sustenance from the intensive culture of one acre. And yet in Japan rice and millet, soy beans, and vegetables are the main crops, while fruit culture is only of secondary importance.

In his highly instructive book, "Farmers of Forty Centuries," Professor F. H. King explains the mystery of China's support of her millions, by giving an account of a visit to the farms of the densely populated province of Shantung. There every scrap of vegetable matter and excrement is saved and returned to the fields, which yield a harvest of wheat or barley in June, and later, aided by midsummer monsoon rains, a second crop, consisting principally of millet, corn, sweet potatoes, peanuts or soy beans, is harvested. One of the farmers in this province had a family of twelve people that he was maintaining on 2½ acres of good farm land, keeping besides one milch cow (also used as a work animal), one donkey and two pigs. But not all of China is so densely populated, and the Chinese have by no means availed themselves of the resources at their disposal.

In many parts of Belgium and France the market gardeners are at present demonstrating what intelligent and intensive horticulture can produce. The small province of Flanders, in Belgium, where so many bloody battles were fought during the World War, is again becoming the market garden of England. Prior to the war one small community exported over 5,000 tons of first-class potatoes and $20,000 worth of pears, while another supplied northern France and Brussels with strawberries. However, there is al-

ways a tendency to employ too much stable manure and animal fertilizers to force the growth of fruits and vegetables, which make the work of the gardeners disagreeable and detracts very much from the nutritive and hygienic value of the products.

In the immediate vicinity of Paris over 75,000 acres are used for the intense cultivation of vegetables, bringing returns as high as $1,200 per acre; while fruit culture is rapidly attaining an equally high state of development. About 1,250 acres are traversed at regular intervals with stone walls, especially erected for the growing of *espalier,* or wall fruits. On account of their southern exposure these walls, having an aggregate length of 400 miles, hasten the ripening of the fruit through increased solar heat by means of reflection of the heat waves from the stones. The average yield from this acreage is about 3,000 tons. Several hundred acres are covered with pear trees, which yield three to four tons per acre. Likewise the city of Lyons, with a population of over half a million, is entirely supplied with vegetables and fruits by suburban gardeners.

Through the erection of glass houses many gardeners defy the seasons by making their own climate. On the island of Jersey, in the English Channel, there is one establishment of greenhouses covering thirteen acres that makes a specialty of raising grapes which ripen continuously from May to October; besides these, many varieties of vegetables are grown. The financial returns from these thirteen acres are equal to what an ordinary farmer by superficial culture of the soil would obtain from 1,300 acres. The island of Guernsey is equally famous for its greenhouses and its wonderful returns from a relatively small acreage.

There are cases on record where enormous crops have been produced by truck gardeners in tracts adjacent to large cities like Chicago and New York. In the market gardens of Florida 450 to 600 bushels of onions, 400 bushels of tomatoes, and 700 bushels of sweet potatoes to the acre are frequently raised. D. L. Hartman, a Florida grower, a few years ago published the following facts and figures in the "Rural New Yorker":

"During one season the sales from one acre of early tomatoes amounted to $454; and from a trifle more than two and a half acres, including an acre of 'earlies,' the remainder mid-season and

late plantings, the total sales amounted to over \$900. From a little less than one acre and a half, \$555 worth of strawberries were sold."

In the city of San Jose, California, Calvin Miller has two Concord grape vines, planted in 1910, which now cover 5,000 square feet, forming a most beautiful arbor. The average yield from these two vines is about 2,000 pounds, which sell readily at 8¢ per pound —equivalent to \$1,300 per acre.

Notwithstanding all this, the American farmer still appears to have a preference for cultivating large acreages for cereals, and cattle raising, rather than the intensive cultivation of a small acreage. It is now over three hundred years since the Pilgrims landed in North America. Subsequent to their advent the immigrants who followed them have been assiduously engaged in felling the forests to make room for surface agriculture, until now we have over 80 million acres of idle unproductive forest land,— an acreage equal to the combined states of New York and Pennsylvania, or to that of England, Scotland and Wales.

It is evident that cereals, which with flesh foods form the principal staple foods throughout the temperate zones, can only feed on the soil surface, leaving the deeper strata untouched. Figured acre per acre, cereal crops are much smaller than tree crops, and it remains for horticulturists and wise, farseeing law-makers to encourage not only the replanting of the devastated forests with suitable nut and fruit bearing trees, but also to reclaim over 600 million acres of swamp land by drainage, and 400 million acres of arid lands by irrigation, thereby making them suitable for the planting of profitable trees—nature's greatest food producers.

From this point of view it is obvious that there is still sufficient room in America for many millions of intelligent immigrants who are willing to devote themselves to modern horticulture, under the guidance and with the financial assistance of the government.

Unfortunately our present legislators do not take this point of view. During the fiscal year, ending June 30, 1921, we expended for the army and navy nearly two billion dollars, while only six per cent of this enormous amount, was appropriated for the Department of Agriculture. Think what could be done for capable and industrious settlers, if the nation would expend in agricultural development what is wasted on war preparations. The words of the Swedish statesman, Count Oxenstierna, who lived three cen-

turies ago, "The world does not know with how little wisdom it is ruled!" are equally true today.

The planting of trees is also of great importance as a natural protection against the extreme changes of atmospheric temperature and pressure. It is a well-established fact that trees purify the air and render the climate more equable, making it cooler in summer and warmer in winter. Thus in wooded districts, the rainfall is more evenly distributed throughout the year than in other places, and storms, hurricanes and tornadoes are less frequent and less violent. The science of forestry clearly shows that we are directly dependent upon forests for necessary rainfall, and that their destruction over a great portion of the earth has been followed by injurious consequences, such as floods and tornadoes.

Fertility can be drawn from greater depths by the planting of trees than by any other crop, so that their culture is equivalent to gaining a larger area, and less artificial drainage is necessary. The roots of the trees are more capable than those of the smaller plants of utilizing the invisible compounds of the soil.

Many plants and fruit trees unfortunately suffer from want of proper elements in the soil, and this accounts for frequent poor yields. Moreover, insufficiently nourished plants and trees fall a prey to diseases more quickly than the well fertilized and stronger specimens. Exhaustion of the soil is probably the cause of more failures in fruit crops than all other causes combined. Sweet and wholesome fruits of good keeping quality can be produced only from a soil that contains all the necessary elements for promoting the normal growth of all parts of the tree. In the production of the eight million tons of fertilizer that are used in the United States every year, special attention is given to only three constituents—nitrogen, potash and phosphoric acid—elements that unduly stimulate the growth of certain parts of the plants to the detriment of others. Soda, lime, magnesia, iron and fluorine are equally important for the healthy growth of the plant or tree.

During the first decade of the present century we witnessed the strange spectacle of thousands of American farmers crossing our northern border line and seeking cheap wheat lands in the bleak Canadian Northwest. Three outstanding causes appear to be responsible for this emigration from a land which was hardly settled, and whose immense areas are possessed of ideal climatic con-

ditions: First, the speculative abuses of our land laws; second, the exhaustion of the soil by unintelligent farming; and, third, the waste by floods due to forest destruction.

Farm life has become more or less unprofitable in the New England states, and the process of deterioration is affecting the farm lands of New York, Ohio, Indiana, Maryland and Virginia. It is said that in one of these states when a man sells his farm he gives away either the value of the building, or the value of the land, since the price is often less than would be required to replace the building. Very few farmers appear to be interested in the intensive, intelligent cultivation of land.

Referring to this situation of American agriculture, and comparing it with conditions in Europe, Professor J. Russell Smith, of Columbia University, has published an interesting article in the *Review of Reviews,* from which the following paragraphs are taken:

"The Anglo-Saxon, with the level-land plow agriculture, brought from England, a land of gentle rain, entered the mountains, felled the fine trees of the rich forest, scratched the sloping earth with a plow and planted corn—corn, the great king crop of the level country,—the poorest crop of the hills. Before this mountain corn crop can ripen, it must be subjected to many rains. Unfortunately, the typical summer rain of the mountains is a tearing, pouring thunderstorm which lets loose on an acre of ground, one, two, three, and even four hundred tons of rushing water in a single hour. It is therefore natural that the earth should be washed away. After the earth has been deprived of its protection of forest and roots, the gashing and loosening by the plow and hoe seem to be a special preparation for its complete removal by the rushing waters. The light loamy soil which, if properly cared for, might nourish a thousand or ten thousand crops, is gone in a few seasons, and merely serves to choke the meadows below and to hinder navigation in the valley streams.

"This hideous, frightful, bootless, ruthless waste does not seem to have even the excuse of enriching one generation of men. The process of corn growing is so laborious on this steep, stumpy, and often rocky new ground that the poor mountaineer gets only a meager crop. In the effort to get much money for little corn, he turns to the distillery to make corn whiskey.

"Great is the contrast between these poor, uncomfortable whiskey cursed, law-breaking mountaineers of Appalachia and the comfortable, prosperous inhabitants of similar, but less favored slopes in Corsica. I have traversed miles of mountain slopes in Corsica having the angle of a house roof. The slope was steep, but a good

road wound in and out along its face. At intervals we passed through villages of substantial stone houses, with well built churches, well stocked stores, and often comfortable inns. The people were farmers who made their living from these slopes despite the house roof steepness. A genuine mountain agriculture has been developed there, a tree agriculture which prospers without the plow and its attendant erosion. The tree can utilize the heat, light, moisture, and fertility of the mountain without imposing upon man the fearful and destructive task of plowing a place that was never meant for the plow. If, perchance, the mountain is so rocky that plowing is impossible, it makes no difference to the tree. It sticks its roots between the rocks and thrives, perhaps even the better, as rocks on the surface check evaporation and keep the moisture in the earth.

"I recall a region in northeastern Corsica where, except for a few breaks not over 100 yards each, I passed for fifteen miles through an open forest of chestnut trees, and *every* tree was grafted to a heavy yielding variety. These forests are really orchards, the sustenance of the people in the many villages. The chestnut is to them what corn is to the Appalachian mountaineer, and more, for does not a chestnut tree once established outlast two or three generations of men? There is always, so I was told, a crop, a large crop succeeding a smaller one, as is the case with many crop yielding trees. Time and again I was told in Corsica and France, by growers, merchants and government officials, that the average yield of a good mature chestnut orchard was from 2,000 to 3,000 pounds of nuts per acre.

"It is easy to see that a high value should attach to a tree that lives for a century or two, produces regularly of valuable crops without labor, and sells for much good money when it is finally felled. I was repeatedly told by reliable Corsicans in 1913 that while unplanted land has practically no value, these orchards are worth from $150 to $250 per acre."

Equally enlightening is what Professor Smith writes about another island, situated a little west of Corsica. The article from which the following paragraphs are taken is entitled "Two Story Agriculture" and was published in *The Century Magazine* several years ago:

"Approximately nine-tenths of the arable area of Majorca, one of the Spanish islands in the Mediterranean, is planted out to crop-yielding trees. That makes one-story agriculture. Then beneath the trees grain is grown. That makes the second story. For miles and miles in every direction that beautiful island is covered with continuous orchards of almonds, olive, figs and carobs, with occasional grafted oak-trees, the sweet acorns of which are prized as

highly as the chestnut. This tree agriculture is nothing new, for many of these orchards are of unknown age, and some of them give evidence of having seen generations of men rise, dig awhile and die before Columbus sailed past on the way from Genoa to Gibraltar; and throughout all the years that the white man has striven in America, these same old olive and carob trees have been standing there, handing down their harvests of fruit and beans to the men who raised other crops at their feet—crops of wheat, oats, barley, beans and peas.

"In the average case it works out that the grain crops pay the cost of the operation, and the tree crops come along and make the profits. The failure of the almonds, or the off years with the carobs or olives, therefore leave no deficits, and the years of good tree harvests are the years of a profit. If, as is at times the case in the best regulated lands, there is a shortage in the grain crop, it has more than an even chance of being equalized that same season by the tree harvest.

"The farmers of southwestern France annually send to the United States millions of pounds of choice Persian (so-called English) walnuts, and yet there are not ten orchards in the whole region. A French farmer gave me this explanation: 'If we planted the trees in regular rows, close together, we could grow nothing between them, for they cast a dense shade; but if we scatter them about the fields, there is plenty of light, and wheat will grow close to the trees.'

"One exceedingly intelligent French proprietor whose place I visited had applied this theory by planting all his fields with walnut trees ninety feet apart. Thirty years hence it will look like a great park that has been planted to grain, and as they approach maturity, every one of his walnut trees will be making more human food than will be furnished by the meat from an acre of pasture. For years (before the war) the selling price of this French walnut tree's harvest was more than the value of the meat produced by the acre of pasture, but no one can predict what prices will be during the one or two centuries that elapse while those walnut trees continue to shed their autumn nuggets of nutrition."

If the early settlers of the New England and Atlantic States had taken a lesson from their former neighbors in southern Europe, they would have planted walnut and chestnut trees in place of the American elm and maple. In this way they would have planted not only equally beautiful trees for shade and ornament, but the nutritious nuts would have furnished a regular source of excellent food, and, very frequently, a good income, not only for themselves but also for their descendants. We boast so much of our natural resources and advantages—and we are justified in doing so—

and yet we have failed to avail ourselves of scarcely more than a small fraction of what we might possess; and the larger portion of our domains still await intelligent attention. There are millions of acres of mountain land within our borders unsuitable for cereals and yet adapted for different varieties of nut-bearing trees.

Our roadsides could be planted as conveniently to nut bearing trees as to other kinds that do not produce any kind of food. A road ten miles long, planted to walnut and chestnut trees on each side, at intervals of forty feet, would furnish room for more than 26,000 trees, as many as could be planted on 100 acres of land. In addition to eventually yielding a handsome yearly income, the valuable by-product of wood, of which there is an increasing scarcity, would be furnished. We are spending millions for imported foods that might easily and with larger profit be produced at home. To be sure the raising of tree crops involves a considerable expenditure of time in which no immediate financial returns are realized; and it is here that a wise government should give assistance, if it really has the welfare of the country at heart.

A great initial step in the right direction was taken by the United States government in passing the Reclamation Act, June 17, 1902. A national movement was organized and about one hundred million dollars invested by the Reclamation Service. The reclaimable area west of the Rocky Mountains is estimated at 30 million acres, which in time, under intensive cultivation, will provide homes for several million families. The principal irrigation projects west of the Rocky Mountains so far completed are; the Orland project, in northern California; the Klamath project in southern Oregon; the Truckee-Carson project in Nevada; the Boise-Idaho project; the Salt River and Yuma projects in Arizona; to which may be added the privately irrigated Imperial Valley of Southern California, fitly called the "American Valley of the Nile." More irrigation projects are still pending, of which the most important ever attempted is the Boulder project of the Colorado River.

During the last thirty years California, through the development of her water resources, supplied by the eternal snows of the High Sierras, has become the leading fruit growing state of the world, and yet, considering her immense area of one hundred million acres, the proportion of land devoted to fruit culture does

not exceed one per cent. California furnishes a fit illustration of how a state at first chiefly devoted to cattle raising, passes into cereal farming, and then, finally, to the more profitable cultivation of fruits—all within the period of the memory of man.

Both the Spanish and Mexican governments formerly made large land grants to encourage settlement. These were exclusively used as cattle ranches up to the time of the American occupation, when the exports consisted entirely of hides and tallows. California, once the Mecca of gold-seekers, has now become world-famous for her orchards, whose annual products far outrank in value all the precious yellow metal ever taken from her soil. And still there are millions of acres now suitable for fruit growing, awaiting the arrival of intelligent settlers to supply the increasing demand for the most wholesome and nutritious products of the soil. The cultivation of cereals and the livestock and dairy industries are prominent, but the area devoted to them is gradually becoming smaller. Barley, wheat, oats and corn occupy less than two million acres; alfalfa, beets, hay, potatoes, etc., about two and a half million acres, which are necessary to feed the still numerous cattle.

California, because of her natural climatic advantages, fertility of soil and abundant water for irrigation, was favored by nature for fruit growing, as against the enormous climatic handicap imposed upon the fruit grower of every other state in the Union. It is not, therefore, too much to assume, that California will eventually supply the fruit of the United States in ever increasing quantities, and, to a large degree, of those countries whose climatic conditions preclude successful fruit growing.

Statistics reveal the surprising fact that within ten years the number of orchard trees in the United States, outside of California and Florida, has decreased about 40 per cent. According to the census of 1910 there were in orchards in the United States, outside of California, over 500 million trees, while the census of 1920 showed less than 300 million trees. At the same time there is every indication that the people in the United States will give fruits a more prominent place in their dietary than ever before, as the nutritive and hygienic value of fruit is becoming more and more appreciated. This condition, will, in years to come, require every acre of land in California adapted to fruit growing.

Despite these circumstances, many California fruit growers

are fearing the possibility of over-production, especially with the unprecedented planting of trees during the last few years. As soon as the people begin to more fully realize the injuriousness of artificial sweets, and the fact that the daily use of fruits is essential for the attainment of health, the consumption will increase enormously and disperse every fear of over-production, especially as the population of the United States is constantly increasing.

California's area is about 7,000 square miles larger than that of Japan, yet her population is less than four millions, whereas the "Flowery Kingdom" sustains a population of nearly sixty millions. Under intensive cultivation, California could support fifty million people, or at least ten times more than it does now, besides supplying the larger part of the United States with fresh and dried fruits.

The world's population has tripled within the last 150 years, and, considering the present rate of increase, there should be more than 3,000 million people living on this planet at the end of the twentieth century. By employing modern methods of agriculture, and horticulture, this large number would be able even now to find more than ample room and sustenance in the temperate zones. And then there remains the tropical area, a source of almost fabulous wealth, in comparison to which the resources of the temperate zones sink into insignificance.

One of the remarkable examples of what can be raised on well cultivated soil, even in a cold climate, is furnished by the fruit-colony "Eden" near Oranienburg, in the Province of Brandenburg (Prussia). There in the course of a few years, under the most unfavorable conditions, by a small number of energetic and intelligent men, a sandy desert has been converted into valuable fruit land which now produces enough, not only to furnish the colony with ample nourishment, but also to supply a number of stores in Berlin, while the members and their families enjoy health and independence.

In 1798 Malthus published his famous essay on "Principles of Population," at the end of a century of devastating wars for the possession of land, when production and distribution of foods were still carried on in a very primitive way. The Malthusian theory was based upon the theory that population, when unchecked, multiplies more rapidly than the means of subsistence. Malthus of course had no vision of the coming age of steam and electricity;

of the wonderful progress of our means of production and distribution by steamships, railways, automobiles and aeroplanes; of the great advancement of agricultural chemistry and the science of nutrition—in other words, Malthus derived his ideas from the appalling stupidity of men, who have to go through famine and war in order to establish a balance between food supply and population.

Even as late as December, 1920, two years after the World War, the *New York Times* published the following item:

"Boston, December, 1920.—The United States will have a population of 197,000,000 people (the maximum which its continental territory can sustain), about the year 2100, Professor Raymond Pearl, of the Johns Hopkins School of Hygiene and Public Health, estimated in a Lowell Institute lecture last night.

" 'To support such a population,' he said, '260 trillion calories of food a year would be needed, and judging from production of the last seven years when the maximum population was reached, it would be necessary to import about half the calories necessary for sustenance.' "

Of course, this estimate is based on our present wasteful methods of agriculture and on irrational theories of nutrition. Even with the intensive culture of a mere fraction of the total area now under cultivation the United States could comfortably support several hundred millions more people.

If the cultivation of cereals were abandoned, nut crops with their large yield per acre, at less expenditure of labor, would furnish more of the food essentials than are now obtained from grain crops. Famine occurs in grain growing rather than in fruit and nut growing districts. Nut trees may be grown upon almost every habitable acre in temperate and tropical zones and their distribution is made easy by the fact that nuts are not perishable like flesh foods and vegetables, and there is plenty of time for gathering the crop.

It has been estimated that the total amount of solar energy stored in plants each year is twenty-two times greater than the amount of energy represented by the coal consumed during the same period of time. About 67 per cent of this plant energy is taken up by the forests; 24 per cent by cultivated plants; 7 per cent by grass of the steppes and prairies, and 2 per cent by the plants of desert lands. The energy received by forests yearly is fourteen

times greater than the energy of coal used during the same period. Unfortunately, the largest forests are mainly in the tropics. In temperate regions the forests are being depleted in about the same proportion as the coal supply is being exhausted.

While we have made such great strides in industry, in many civilized countries intensive agriculture and horticulture, and above all, the scientific nutrition of man have not yet received the serious study which they deserve.

In his interesting and instructive book on "Nut Growing" Robert T. Morris very pointedly says, in part:

"Our agriculture in North America represents a tradition from level lands and dating back to the days of savages when men had to devote most all of their time to killing each other along with other large and small game, while women raised small annual crops of grains. In those days the kaleidoscopic shifting of tribes was inimical to tree culture but fitted better into the cultivation of annual plants. . . . . *Tradition in agriculture has meant wicked waste of opportunity in America and it is now time for us to awaken to the situation and teach the old world what may be done with our new agriculture upon nut tree crops.* (The italics are mine.)

"Japan appears to be crowded because of agricultural thought-habit. Japanese chestnuts, heartnuts and pinenuts would furnish a better balanced food ration than common rice diet. The physical strength of the people would be increased in the course of a single generation on a nut diet. North American nut trees and nut bearing annual plants would thrive in Japan, furnishing a luxurious range in qualities of food besides supporting a population many times greater than that of Japan today. This country might increase its national wealth by exporting nut crops to other countries.

"Japanese scientists, ranking among the highest in the world, know very well how Japan might set an example for all civilization if battleship money were to be turned over to agricultural educational institutions. Thus would a proud people have justification for a pride based upon pragmatic results of application of keen intelligence to the food question.

"It is said that a machine victory is the only possible victory over the land in these days when there is an increasing tendency for men to leave the land and go to the cities, but the tree is a machine. So is the annual plant a machine, for that matter, *but the tree is a machine that is working day and night with less attention required from man than the annual plant requires.* (The italics are mine.)

"Agricultural experts in our colleges can make people believe that we have enough land to supply food, but the question is one

of distribution of knowledge which should be a function of the state. Not only may abandoned farms be made more profitable tomorrow than they were when at their best yesterday, but many of the so-called waste lands may be made to produce more food than has been commonly produced by soil of first choice. Even the swamp lands hold out an attractive feature for the producer who finds joy in new fields calling for a wider range of his keen interest and knowledge.

"According to the 1914 report from our Department of Agriculture, forty per cent of the land in the United States is non-tillable. Aside from the non-tillable land which consists of swamps in which food might be raised profitably, a very large percentage of the entire acreage on higher ground already carries tree or brush crops for which we may substitute food-bearing nut trees and shrubs. There is but a small percentage of this untillable land, excepting that on bleak, barren mountain tops, which cannot be made to raise nut crops more valuable than most of the crops which are raised upon the tillable land in the State. Only twenty-seven per cent of the land in the United States is actually under cultivation, but if we follow the same (wasteful) methods of plant and stock raising in the future it will not be long before one hundred per cent is occupied. *As a matter of fact, intensive cultivation of twenty per cent of the tillable land now occupied could be made to produce so much more than it does under present methods that we need have very little anxiety about the need for bringing one more acre of tillable land under cultivation with ordinary crops for some time to come.* (The italics are mine.)

"One may ride for mile after mile upon the railroads through old settled parts of New York and New England and see on every side wornout sheep pastures supporting many woodchucks and grasshoppers, that could be made to yield good income. On some of the western prairies one may look clear to the horizon and see only French weed, thistles and wild mustard, where once was corn and waving grain—the land now practically abandoned because farmers would not change their crops or do subsoil plowing. While this state of things remains it is all wrong to open up more unimproved land. We are simply increasing competition between men engaged in the lower planes of agriculture. . . .

"Is there a deserted hillside sheep-pasture in the east or a mustard prairie in the middle west that cannot be made to grow one hundred dollars' worth of nuts per acre annually? Probably not.

"The attempt to raise corn and other grain crops on the Appalachian hillsides has been extremely destructive because of soil erosion following in localities, whereas nut tree crops would have given much larger incomes from the same land, with the avoidance of erosion and exhaustion of the soil. The deserted farmlands of the eastern states would not be deserted, but would be yielding

larger permanent incomes if tree crops of grafted acorns, hickories, beeches, hazels and black walnuts had been planted where now the ground is occupied by chipmunks and sumac.

"Thousands of square miles of hilly land that are now being gullied as a result of raising meagre crops of annual plants may be put into tree-crops and saved. Lands that are level or moderately rolling are the only ones in this country that we can afford to devote to crops of annual plants. The loss of land in hilly districts concerns not only the people of today, but the generations of tomorrow as well. . . . .

"A great development of cereals took place as a result of experimental work during the nineteenth century, but the twentieth century is signalized by the sudden emergence of nut culture. There are several reasons for this unexpected event:

"1. Shortage of farm labor due to decreasing birthrate and increase of movement toward urban life came acutely to our attention in the early years of 1900.

"2. Nut trees produce more food essentials in proteins, oils, and starches per acre than are furnished by ordinary field crops.

"3. Nut crops require less labor in cultivation, or for harvesting the crops. The trees may live and bear for more than a century, sometimes without apparent reduction of the fertility of the soil in which they grow. Difficulties which formerly stood in the way of successful propagation of nut trees have been done away with to such an extent that almost any boy or girl may do grafting work of the sort which defeated the efforts of expert horticulturists two or three years ago.

"Nut cultivation belongs to what has been called permanent agriculture. The meaning of the expression is clear. Transitory agriculture might be the opposite term as applied to rotation of annual plants. A tree does not exhaust the soil as a rule, while transitory agriculture regularly exhausts the soil unless fertilizers and methods of cultivation are employed with a higher degree of intelligence than is commonly in evidence. The profitable employment of fertilizers in crop rotation demands knowledge of such high order that comparatively few farmers are prepared to avail themselves of what is known on the subject. Permanent agriculture on the other hand will allow a very much larger number of people to furnish foodstuffs with a comparatively small equipment of information.

"An acre of land devoted to wheat may produce nearly ten times as much protein as the same acre devoted to pasturage for beef cattle. An acre of land devoted to nuts may be made to produce a still larger amount of food protein than is to be obtained from this wheat which in turn, had excelled the beef acre. . . . . The average number of food units per pound furnished by the more

common varieties of nuts is three thousand and thirty-one calories, while the average of the same number of varieties of cereals is sixteen hundred and fifty-four calories. The average value of the six principal flesh foods is eight hundred and ten calories per pound, or one-fourth that of the nuts.

"Although we are prone to speak of protein as a unit food substance, proteins from different food products vary largely in character. Nuts furnish proteins of such fine quality that they supply the elements necessary to render more complete the proteins of cereals and other vegetable foods. *They are free from waste products such as uric acid, urea and creatinin which are contained in flesh foods. Furthermore, nuts are nearly aseptic and free from bacteria of putrefaction which abound in meat.*

"From an economic standpoint the raising of nuts has a great advantage over the raising of meat. One hundred pounds of food fed into a steer produce less than three pounds of food in the form of flesh. We must feed the steer thirty-three pounds of corn in order to get back one pound in the form of steak. (The italics are mine.)

"Milk and eggs furnish much the same protein as that furnished by meat, but milk and eggs are rapidly increasing in price. Every pound of food in the form of milk requires feeding a cow five pounds of food. For every pound in the form of eggs we must supply nearly twenty pounds of food. At the present time the price of nuts is also high, but that is because the demand has not been met by the supply. Looking into the future we may state that the possibilities of raising food more cheaply by the cultivation of nuts are greater than the possibilities of raising food more cheaply by dairy farming. In this connection it is interesting to note that one pound of walnut meats equals in food value five pounds of eggs (40), nine and a half pounds (or pints) of milk, or four pounds of beef loin. Each acre of walnut trees in good bearing will produce every year food approximating twenty-five hundred pounds of beef, thirty-five hundred quarts of milk and one and a half tons of mutton.

"Aside from such prosaic considerations as those of food supply, interest in trees belongs to a higher order than interest in potatoes, oats and hay. There is more inspiration in a tree than in an annual plant because the tree is an object lesson of highly organized forces, more stable and permanent than those of annual plants. The larger love which men seem to have instinctively for trees will elevate standards of agriculturalists who deal with them."

Agriculture and horticulture are yet in their infancy; the small farmer is portrayed as "the man with a hoe" or bending dejectedly over a plough, the epitome of drudgery and toil. In the not far distant future, we shall enjoy the inspiration of an

entirely different picture. The cultivator of the soil will stand erect with head unbowed. A few hours' devotion each day to the prosecution of rational farming will furnish sufficient food for the nourishment of his family, and an ample surplus for the market. The man who merely toils never makes much progress. He must combine love of nature with a desire to make the very best of his opportunities—to live the simple and useful life, and yet enjoy, by cooperating with his fellow men, all the advantages of modern civilization. This is the spirit of the New Agriculture, the initial stepping-stone to a better civilization that assumes the health and happiness of the individual to be paramount to all other considerations.

Sampson Morgan, the English pioneer of the New Agriculture, writes in his book "New Soil Science":

"I contend that by living the simple life in the fruit field, a man can fully depend on satisfying every reasonable want through an acre of land if needs be. With a few acres, comparative comfort can be secured. It should not be forgotten that from the area occupied by twelve dwarf trees alone, twelve bushels of fruit can be procured each year. There is thus ample space left for producing sufficient products for sale even if only one acre of land is taken in hand. From a few trees of really good eating apples and other kinds, a full supply of these fruits can be assured almost all the year round. Fresh fruits can readily be grown and enjoyed in this country (England) from one year's end to another. By the improved system, giant fruits and berries, which will command a limitless sale at good profits, can be produced by anyone having a liking for the work after a little experience.

"Perfect fruit alone can meet the demands of the human system; perfect fruit alone can stimulate the intellect; perfect fruit alone can control the feverish activity of the arterial pulsations which, aided by the consumption of inflammatory foods and drinks, wear out the human machine long before its natural time. Physically and intellectually, the coming race can best be perfected by being moulded under the magical influences which exist in the fruit field and in the fruit field alone."

For health and delight, the garden and the orchard are the universal and supreme ideal of man. In every normal human being there is the constant yearning for the day when he may own an acre of land and plant it with trees that blossom and bear fruit. This love of country and orchard is the one abiding memory of an almost forgotten paradise. How beautiful is the sight of an orchard with

its blooming trees sending their roots deep down into the soil, drinking in the heavenly light, with its millions of blossoms, bringing forth the luscious fruits in which the hidden treasures of the earth and the life-giving forces of the sun are so wonderfully combined!

Man, after all, will cling to the land, he will see that it is the earth which nourishes him best, and like the giant Antaeus, he will ever have need to touch it, to feel it beneath his feet, in order to renew his strength. The time must surely come when science and the cooperation of mankind will have cultivated the earth to such a degree of perfection that it will bring happiness and contentment to all. Then the shadows of disease, famine, murder and war will disappear from our planet like the mists of dawn before the radiant light of the rising sun.

CHAPTER X

Stimulants, Narcotics and Condiments

It is a most significant fact that hand in hand with the increasing consumption of devitalized and demineralized foods, the use of stimulants and narcotics, such as alcohol, spices, tobacco, coffee, tea, cacao, coca, kola, etc., has assumed such proportions that it may well be considered one of the most serious sociological problems. If through lack of the important organic salts, the body is undernourished, it becomes easily fatigued because of insufficient oxidation and elimination, and a craving for something to stimulate the declining vital forces is easily acquired.

While our modern system of commercialism with its highly improved methods of production and distribution has accomplished much good, it has also brought within the reach of the masses the thousands of varieties of artificially prepared foods and stimulants whose exponents, through the medium of shrewd advertising, have been untiring in their efforts to establish belief in their efficiency and usefulness.

The indiscriminate and habitual use of stimulants and narcotics gradually deadens the natural sensations, induces the retention of waste matter in the system, awakens a false desire for food, and finally ruins all power of discrimination. The craving of the nerves becomes abnormal, while natural food flavors appear insipid or are even despised. Modern cookery, in its attempt to satisfy perverted appetite, is responsible to a large degree for these deplorable conditions.

The amount spent for stimulants and narcotics throughout the world every year probably equals the sum that the World War cost the United States—about twenty-four billion dollars. However, the most appalling and irreparable loss induced by these nerve poisons, comes through impaired health, which reveals itself in enervation, lessened physical and mental efficiency, diseases of the heart and respiratory system, and premature death.

ALCOHOLIC BEVERAGES

Alcohol, *per se,* has no place in the vital economy of the body, and the theory that it has food value has been exploded for some time. During the process of the fermentation of fruit or vegetable juices, their sugar is converted into about equal parts of alcohol and carbonic acid. Alcohol being a product of decomposition cannot impart any actual force or energy to the body, but on the contrary, is a poisonous substance, a destroyer of the life protoplasm, and a dangerous stimulant to the nervous system. Naturally, the higher the percentage of alcohol in a beverage the more injurious it is to the life of the vegetable or animal cell.

Distilled liquors, containing 50 per cent or more of alcohol, are prescribed in small quantities as a medicine, but with no more justification than the recommendation of other drugs. It has been demonstrated by a series of experiments that alcohol does not burn up in our organs, but merely passes through the system, lodging for the time being in the nerve centers, where it creates excitement or intoxication, and is in turn slowly eliminated by the skin, lungs or kidneys, or at the most, only oxidized in a very small proportion in the form of aldehyde.

From an economic point of view, the manufacture of alcoholic beverages is a most tremendous waste of good food material, especially of wholesome fruits. In the wine producing countries, notably around the Mediterranean Sea, an enormous quantity of grapes is practically destroyed every year by fermentation in the production of wine and brandy. According to statistics, the world's annual output of the fermented and distilled juice of the grape averages 5,000 million gallons, which contain 8 to 12 per cent alcohol. The volume of the latter in one gallon is about one pint, which involves the destruction of two pounds of fruit sugar. Thus the total amount of natural wholesome sugar lost in the making of wine alone is ten billion pounds, or nearly five million tons every year.

The world's annual output of commercial sugar is constantly increasing, and now amounts to about twenty million tons, while about half of this amount is turned into alcohol by the production of fermented and distilled liquors. How preposterous it is, then, to destroy the natural fruit sugar by fermentation, and at the

same time, by chemical and mechanical processes, to extract from beets and sugar cane an artificial and demineralized product!

The destruction of cereals in the breweries and distilleries is equally enormous, and the waste of food material can only be imagined by those who have closely studied the subject. Up to 1919 in the United States alone, more than 100 million bushels of cereals and potatoes were annually used in the production of alcoholic beverages. On the banks of the Ohio and Illinois rivers numerous distilleries were engaged in converting into whisky sufficient cereals to supply at least three such cities as Greater New York with bread, and give a feast to all the needy on earth. In Europe immense droves of swine are still fed and fattened on the offal of such establishments, and the scrofulous pork resulting therefrom is sent into cities to engender disease.

There are still many who advocate the use of light alcoholic beverages in place of the stronger ones, claiming that civilized man must have a stimulant, and that wine and beer have been used for thousands of years. Taking into account only historically established facts, we have good reason to believe that the use of alcoholic beverages originated comparatively late in the evolutionary march of the human race, and that it hardly extends over 6,000 years. The ancient civilization whose poets have chanted the praises of wine and worshipped at the shrine of Bacchus, have crumbled into dust and their descendants are but shadows of their early progenitors who before founding their empires led a natural life. The fact that a custom is time honored, does not justify its continued existence. Acquired and ingrained habits are hard to give up, and the victim readily finds an excuse for his persistence in using them.

Alcoholic stimulants so permeate all phases of social life, especially in Europe, that one can scarcely conceive of a festive affair devoid of them in one form or another. Upon entering an eating house in Europe the guest is first presented with a wine card, and interrogated as to what he will have to drink. A negative reply evokes surprise and even disdain, as it is the custom to spend at least as much for alcoholic beverages as for food. In France—the wine-drinking country *par excellence*—a bottle of wine is generally included in the price of a dinner, which would not be considered perfect without it. Indeed, so strongly has the wine

drinking habit taken possession of the French people that the average per capita consumption is forty gallons per year. About one-sixth of the population of France is engaged in the cultivation of the grape and the manufacture of wine, so that the commercial prosperity of that country depends upon the sale of the products of its millions of acres of vineyards.

Italy, Spain, Greece, Hungary, Southern Russia, Algeria, South Africa, Chili and Argentina produce enormous quantities of wine, which has become a national drink in many of these countries and supplies a large percentage of the internal revenues. In fact, most civilized countries depend upon the manufacture and sale of alcoholic beverages as one of the principal revenues.

Considering these conditions in the light of human welfare and progress, we cannot deny that one of the most important problems confronting human society today is the increasing consumption of intoxicating liquors, which is one of the fundamental causes of the mental and physical degeneration of man. Statistics show that before the World War the United States, Great Britain, France, Germany and Russia, each spent annually an average of one billion dollars for alcoholic beverages.

There must be some deeper cause for these deplorable conditions than merely acquired customs and habits, and we must look for this in the irrational and impoverished diet of the majority of people. It has been truly said that cooks make more drunkards than brewers, wine makers, and distillers. The relation of diet to intemperance is well worth our most careful and earnest consideration. Temperance reformers should bear in mind that the craving for alcoholic beverages, or other stimulants, goes hand in hand with the increasing consumption of devitalized foods, spices, condiments, table salt, and consequent overeating, which lowers vitality and causes the retention of toxins. This abnormal condition, intensified by the enervating struggle imposed on all civilized nations by modern commercialism, lays the foundation for habitual craving for stimulants and narcotics in one form or another. The prohibitionists are prone to make alcohol the scapegoat of all evils, but they will never achieve any permanent success with their one-sided efforts without removing the real causes. Since the passing of the Volstead Act in the United States the drugstores do an increasing business in all kinds of preparations that

contain a "nerve tonic" in the form of alcoholic beverages. In the manufacture of a well known patent medicine 250 barrels of alcohol are used weekly, and most of the nostrums constantly advertised all over the country contain from 20 to 25 per cent of alcohol, in addition to nerve deadening drugs.

True temperance reform must go hand in hand with diet reform. A simple and frugal diet, combined with regular exercise in the open air will gradually purify the system from waste poisons and, to a large degree, lessen the craving for alcoholic beverages.

COFFEE

Coffee, next to alcohol, is one of the most universally used stimulants. Since the seventeenth century, when the Dutch traders brought coffee from Arabia, Upper Egypt and Abyssinia into the East Indian colonies, then to western Europe, the use of coffee has spread over the entire world. The consumption has increased continuously, especially during the nineteenth century. The three countries, England, France, and Germany, now consume about 500 million pounds annually.

The coffee plant *(coffea arabica)* is an evergreen tropical shrub. The leaves bear at their axil the berry-shaped and elongated red fruits, containing two seeds. These seeds or berries are separated from the endocarp, and after they are washed and sun-dried, form the green coffee beans of commerce. In this shape the berries are of a hard consistency, almost tasteless, but after being roasted at a temperature of about 450° degrees F., essences develop from the destruction of the soluble principles and dissolve in the oily bodies which impregnate the caramelized cellulose and saccharine matter. The chemical analysis of unroasted coffee shows an average of 12 per cent water; 14 per cent nitrogenous matter; 14 per cent fat and oils; 33 per cent cellulose; 10 per cent saccharine matter and dextrin; 4 per cent mineral matter; traces of fragrant oil, and 1 to 2 per cent of caffein, partly combined with a special tannic acid. Caffein, which is the active alkaloid principle of the berry, is not appreciably modified by roasting. It temporarily increases the temperature of the internal organs, while at the same time it reduces the temperature of the skin. In moderate doses it stimulates the heart's action, and causes a rise of the arterial pressure by contraction of the little peripheral vessels.

In stronger doses it depresses the nervous system and cerebral centers. In its stimulating effects caffein therefore resembles alcohol, and its abuse leads to serious troubles of the circulatory system and muscular enervation.

It is not surprising that under the strain of the present competitive system, the consumption of coffee and tea has rapidly increased within the last ten years, and although these drinks are not quite so injurious as alcoholic liquors, if taken only occasionally and in moderate quantities, nevertheless they exert an injurious influence upon the nervous system, due to the amount of alkaloids present.

According to the *American Food Journal,* the per capita consumption of coffee in the United States has steadily increased for many years. The average consumption in 1921 was about 12½ pounds per capita against an average of slightly less than five pounds per capita in the decade ending with 1870; 8½ pounds per capita in the period 1891-5; 9½ pounds per capita in the period of 1906-1913; and coffee consumption has averaged since the beginning of the World War over 10 pounds per capita, advancing to 12½ pounds in 1921. Approximately one-half of the coffee produced in the world is consumed in the United States. In fact, coffee has become our national beverage.

Taking into consideration the large number of infants and children that drink little or no coffee, it seems reasonable to suppose that the coffee consumption by adults is fully double the amount named, or not less than 25 pounds per year. Now, assuming that average coffee contains 1 per cent of caffein (some coffee contains more) this would give to each coffee drinker an average of 5 grains of caffein per day (more than two medicinal doses such as surgeons give to patients suffering from shock, to raise the blood pressure), certainly an adequate cause for the increase in the number of persons suffering from high blood pressure, and diseases of heart and arteries.

If the use of coffee continues to increase at the present ratio, it will, in the not distant future, become as great a source of injury to the American people as alcohol. Many drinks dispensed at soda fountains contain a considerable amount of caffein.

TEA

Tea, like coffee, is now used to a greater or lesser extent in most countries. It is an infusion of the rolled and dried leaves of the *thea sinensis*, a shrub that has been cultivated in China and Japan for thousands of years. The stimulating principle of tea is thein, an alkaloid, resembling caffein. The quality of the various kinds of tea depends upon the time the leaves are picked and on the treatment to which they are afterward subjected. Tea gathered in the spring is considered the best. Green tea is made from the first leaves of the year which are dried and slightly heated soon after they are picked. Black tea is submitted to a slight fermentation before being dried. Then it is re-heated several times upon metal plates.

Green teas generally contain more thein than black teas, which have about two per cent. According to Dr. Koenig the average composition of tea is as follows in per cent of the total:

Water	9.51	Gum and Dextrin	6.45
Nitrogenous matter	24.50	Tannin	15.65
Thein	3.58	Pectins	16.02
Essential oil	0.68	Cellulose	11.58
Resines, chlorophyll and fats	6.39	Mineral matter	5.65

An infusion of tea made with boiling water, standing about five minutes, contains about one-third of the soluble matters of the leaves.

The consumption of tea in the United States is much less than that of coffee, being a little more than one pound per capita yearly. The consumption of the beverage is much larger in England, where it amounts to about 6 pounds per capita. Tea is the national beverage in all oriental countries.

A cup of tea of about 4 ounces does not contain more than 6 grains of soluble substances, and one-half grain of thein; also traces of xanthin. Tea leaves contain a considerable amount of tannin which is partly combined with thein. The organic salts consist chiefly of phosphate of potash, lime, magnesia and manganese.

While tea and coffee are not as injurious as alcoholic beverages, their habitual use will affect the heart and blood vessels and increase blood pressure. The danger of caffein and thein lies in

the fact that they destroy the sense of fatigue, without imparting any vital energy, thus gradually leading to enervation.

KOLA

Kola is a stimulating beverage made from the seeds of the kolanut, the product of a tropical tree *(cola acuminata).* The nut itself is highly prized as a condiment by the natives of Africa, the West Indies, and Brazil. The average composition of ten varieties of kolanuts is as follows:

Water	13.50 per cent	Cellulose	7.00 per cent
Nitrogenous matter	1.53 " "	Tannin	3.79 " "
Caffein	2.08 " "	Other non-nitrogenous matter	18.21 " "
Fat	1.35 " "	Mineral matter	2.90 " "
Starch	45.40 " "		

The other alkaloid in kolanut besides caffein is kolanin. The fresh, undried nuts contain very little kolanin, which is developed by fermentation under the influence of an enzyme. A beverage is made by adding a teaspoonful of the powdered nut to one-half pint of water and boiling it for five minutes. Opinion is divided as to whether the after effects of kolanin are as injurious as those of many other narcotics.

The properties of the kola nut as an agent for the relief of fatigue have been unduly exaggerated, mainly for commercial purposes. For some time it was assumed that this nut contained a peculiar property which increased endurance, but careful investigation revealed the fact that its chief active principle is caffein, and to this the temporary exhilarating effect of the drug must be attributed. Shrewd and unscrupulous manufacturers at the present time use mixtures of caffein and burnt sugar, instead of kolanuts, in the preparation of various drinks. As the alleged virtues of both coca leaves and kolanuts have been exaggerated, it is but natural that a number of preparations are manufactured with misleading names which suggest the presence of both products. Some of the widely advertised soft drinks generally contain, in addition to caffein, the habit forming drug, cocaine. Many people become addicted to the use of medicated soft drinks as others do to alcoholic beverages. It is also quite probable that the extensive use of the kola nut by the natives of tropical Africa is one of the

contributing causes of sleeping sickness, which is believed to be caused by the bite of the tsetse fly.

MATÉ

Maté, or Paraguay tea, consists of the leaves of a species of holly, the *ilex paraguayensis,* which grows in the forests of Paraguay, southern Brazil, and in the Argentine Republic. Maté has been used in South America for centuries, in the same way that the Chinese prepare tea. The plant is now extensively cultivated but the production is not yet equal to the increasing demand. The consumption is eight million pounds yearly in its native countries; the dried and powdered leaves smelling slightly of tan form the basis of the decoction, which has an aromatic but somewhat bitter and astringent taste.

The tonic and stimulating properties of maté are chiefly due to thein, of which the leaves contain from 0.5 to 1.8 per cent. It is imported in small quantities to the United States, and appears to find favor with many people, since on account of its smaller amount of thein, it is less stimulating than tea and coffee. The leaves are very rich in alkaline elements.

COCOA AND CHOCOLATE

The cocoa tree *(theobroma cacao)* was cultivated, and its products highly esteemed in Mexico and Peru previous to the discovery of the American Continent by Columbus, who brought the first cacao (or cocoa) beans to Spain. Cacao was introduced in England in the middle of the seventeenth century, from which its use spread throughout continental Europe, together with coffee and tea, but the higher price of cacao kept it a long time among the luxuries of the wealthy.

The botanical name of the tree "theobroma" is derived from the Greek and means "Food of the Gods" while the word "chocolate" is of Aztec origin, composed of *choco* (cocoa) and *latl* (water), and refers particularly to the drink made from the roasted and ground beans.

Cacao is now commercially grown throughout tropical America. The tree is of low stature, reaching from 16 to 18 feet in height. The leaves are large, smooth and glossy, of elliptic shape, growing principally at the ends of branches, but sometimes springing

directly from the main trunk. The flowers are small and grow in numerous clusters on the main branches and the trunk, a very marked peculiarity which gives the matured fruit the appearance of being artificially attached to the tree. When ripe the fruit or "pod" is somewhat like a cucumber in shape, from 7 to 10 inches in length, and from 3 to 4½ inches in diameter. It has a hard, thick, leathery rind of rich purplish yellow color, externally rough and marked with ten very distinct longitudinal ribs or elevations. The interior of the fruit has five segments, each containing a row of from 5 to 10 seeds, which constitute the raw cacao or "cocoa beans" of commerce. The pulp of the fruit has a sweetish, but not unpleasant taste, and is frequently eaten in the countries in which the tree grows.

When the fruit is gathered, the seed is removed from the pod and subjected to from two to seven days' fermentation in tins, earthen vessels, or in heaps on the ground till the pulp is decomposed. After the process of fermentation, the beans are carefully dried under uniform conditions of warmth and moisture. In the manufacturing process the seeds are screened, roasted, and shelled, the kernels being known as cacao nibs. The hulls are often used as a cheap substitute for cacao. About sixty per cent of the fat is removed and placed on the market in cakes known as cacao butter. The residue of the cacao nibs is ground, boxed, and sold as solid "cocoa" or is pressed into cakes after being sweetened, and is known as chocolate.

The shelled cacao beans with their fat show the following composition, which varies according to the locality where they are grown.

Water	4.5 to 8 per cent
Protein	11.0 " 15 " "
Fats	40.0 " 51 " "
Coloring matter and tannin	2.0 " 3 " "
Starch	3.0 " 4 " "
Crude fiber	5.0 " 10 " "
Theobromine	1.0 " 3 " "
Mineral matter	3.0 " 4 " "

The organic salts consist largely of phosphate of potash, phosphate of magnesia and sulphuric acid. Iron and lime are found only in small quantities.

Cacao, after it has been partly deprived of its fat, contains

about six per cent water, 17 per cent protein, 12 per cent carbohydrates, 1.3 per cent theobromine. It is frequently adulterated with rice meal, oatmeal, flour, potato starch, roasted nuts, etc.

Chocolate is prepared by grinding finely 4 to 5 parts of sugar with six parts of cacao, with a little vanilla extract. The stimulating action of cocoa and chocolate is due to the alkaloid theobromine, but its effect is not so pronounced as in tea and coffee.

Although the products of cacao have considerable food value they should be used but sparingly, as they are highly acid forming. Chocolate in its various forms, containing as it does over fifty per cent cane sugar and about 25 per cent fat, is a highly concentrated food, but deficient in vitamins and alkaline salts.

The world's annual production of cacao is about 500 million pounds, of which 25 per cent are consumed in the United States. A large part is used in the manufacture of chocolate candies, which have become quite a favorite with the American people, who eat them in excessive quantities. While the occasional use of these products may not do much harm, there is danger that they will create a morbid craving for artificial sweets, and over-indulgence will soon produce acidity of the blood, followed by severe catarrhal conditions, adenoids and functional diseases.

OPIUM

Opium is one of the strongest narcotics known. It is prepared from the dried juice of the opium poppy (*papaver somniferum*). It is chiefly grown in southeastern Europe, western Asia, and India. Its activity is principally due to the vegetable alkaloid morphia, or morphine, of which good opium contains on an average about 10 per cent. Morphine was the first of the alkaloids discovered by modern chemistry at the beginning of the nineteenth century, although opium has been used as a drug since the beginning of the Christian era. In the middle ages the various kinds of opium prepared in Persia were known as "theriaka." It was introduced into China probably by the Arabs in the fourteenth century, and was at first used as a remedy for dysentery, diarrhoea, and fevers, and was usually brought from India by the Chinese as return cargo. Through its use for medicinal purposes, opium eating and smoking soon became a firmly established habit throughout the Orient. In that respect it resembles alcohol, a crav-

ing for which is often established by first using it when disguised as a medicinal preparation.

Opium if taken in very small doses of less than a grain, produces an agreeable sensation stimulating the imagination by blunting reason and memory, followed by a desire to sleep. The awaking is accompanied by a feeling of depression and dryness of the mouth and throat. In large doses, as from two to four grains, the stage of excitement is followed by mental and physical depression and irresistible sleepiness, nausea and headache. Opium is frequently administered hypodermically with the same effect.

Opium eating is chiefly practiced in Asia Minor, Persia, and India, and this method of taking the drug is generally considered much more deleterious than opium smoking, which is a firmly established habit in China, the islands of the Indian Archipelago, and in the countries where Chinese labor is largely employed. Since the East India Company began to monopolize the opium trade in eastern Asia in 1757, the imports into China have enormously increased in spite of the continuous protest of the Chinese government.

In 1839 a proclamation was issued threatening hostile measures if the English opium ships serving as depots were not sent away, but the British continued to smuggle cargoes on shore. Outrages committed on both sides led to the so-called opium war which was ended by the treaty of Nanking in 1842. But so firmly had the opium smoking habit taken hold of the Chinese, that in spite of all further remonstrance of the Chinese government, the exportation of opium from India to China has continued, and in 1880 reached the enormous amount of thirteen million pounds! In 1858 it was estimated that about two million Chinese smoked opium, and in 1878 from one-fourth to three-tenths of the entire population of 400 millions used it. An especially prepared extract of opium is used for smoking.

Realizing the seriousness of these conditions, in 1907 an agreement was made between Great Britain and China by which the Indian government was to reduce annually the exportation of opium into China, and the poppy raising industry in India was to be correspondingly curtailed. This agreement, renewed in 1911, anticipated the extinction of the opium trade by 1917. While this agreement has not been strictly adhered to, partly because of

the laxity of the Chinese government, nevertheless, there has been a decrease in the trade and in the opium habit.

The opium trade is characteristic of modern commercialism, in that it endeavors to force its wares upon people for the mere sake of private gain, irrespective of the injurious influences upon public health. In every way opium smoking may be regarded in the same light as the use of alcoholic stimulants. The use of the drug is opposed by all thinking Chinese who are not pecuniarily interested in the opium trade. Among the reasons urged by the Chinese against the consumption of opium are, that it drains money from the country by spreading the drug habit; causes sterility; increases the possibility of famine through cultivation of the poppy where cereals and fruits should be grown, and leads to the corruption of state officials.

Twenty different kinds of opiates are derived from opium, of which the most frequently used are morphine and heroin. Morphine, which constitutes about one-tenth of crude opium, seldom appears outside of chemical laboratories, unless it is combined with some other drug. Heroin, a compound made artificially from morphine, is the most poisonous opiate known. Four-fifths of 2,300 patients treated at the Riverside Hospital, New York, were addicted to heroin.

There are nine thousand tons of opium produced every year, and only three and a half tons are needed for legitimate use! What becomes of 8,996½ tons that are not legitimately accounted for? Three-fourths of the deadly stuff that spells ruin, degradation to mind and soul and body, comes to the United States of America. The narcotic drug traffic has almost trebled in America in the past two years. In fact we now use seventeen times more per capita than the Chinese, who have always been considered the most drug-cursed nation of the world.

Austria uses one-half grain of opium, yearly, for each man, woman and child; Italy 1 grain; Germany and Portugal, 2 grains; France, 3 grains; Holland, 3½ grains, and the *United States, 36 grains per capita per year!* The probability is, however, that there are more than 1,000,000 victims in the United States who use from 2½ to 3 grains daily. The habit does not remain static in the individual, but increases with appalling swiftness. It takes but thirty days, at the most, to make a full-fledged addict, and even

the first dose is frequently habit-forming. As long as foreign nations permit and encourage the growing of the poppy and the manufacture of patent medicines containing opium is going on, America's drug habit will seize more victims every year.

COCA AND COCAINE

Coca is made from the leaves of the coca shrub (*erythroxylum coca)* which is extensively cultivated in Peru and Bolivia. The natives chew the leaves which they claim appease hunger and fatigue. For this purpose the leaves of commerce are by no means as active as freshly dried leaves, though it appears that they have been extensively exploited for commercial purposes. Its stimulating effects are largely due to its alkaloid, *cocaine,* whose properties resemble those of opium. It is one of the most insidious and dangerous habit forming drugs known at present. Within recent years it has been employed as an anaesthetic in major surgical operations. If injected into the spinal canal, cocaine has the remarkable effect of producing complete insensibility to pain in the entire portion of the body below the point where it is injected, but has no effect whatever above that point. Like opium, cocaine is used in the manufacture of patent medicines, especially catarrhal remedies. Cocaine is frequently obtained by drug addicts under false pretenses, and the amount annually consumed at present in the leading civilized countries is estimated approximately at 1,500 tons.

Only about 7 per cent of this amount is used in dental and other legitimate practice. What becomes of the other 93 per cent?

Not only are the drug-traffickers enriched by smuggled dope, but by an astounding proportion of that imported through regular illegitimate media. Last year's importations of narcotics amounted to 292,971,000 grains.

"Of this amount," says Colonel L. G. Nutt, chief of the narcotic section, Bureau of Internal Revenue, "we estimate from 65 to 80 per cent found its way into illicit channels!" Estimating the amount of smuggled dope at approximately the amount brought in openly, or from 275,000,000 to 300,000,000 grains, a total of at least half a billion grains handled through illicit channels is declared reasonable.

"Here is what this means in the way of profits to the dope sellers. Morphine, at wholesale from the manufacturer, brings

from a cent to a cent and three-quarters a grain,'' says Colonel Nutt. ''Our men are buying it from dope peddlers at from 5 cents to as high as $5.00 a grain. The average price to the dope user, we find, is about $1 a grain. In many cities, however, it brings $2.00 or more. I would place the average at least at $1.00 a grain, which means a 'dope' bill to users in this country of at least $500,000,000 a year.''

HEMP

Hemp *(canabis sativa)* is grown for three products: the fibre of its stem, its oily seeds, the resinous secretion which in hot countries is developed upon its leaves and flowering heads. It is this last named product that closely resembles opium in its action upon the nervous system. The intoxicating properties of hemp have been recognized in Oriental countries from a very early period, and during the Middle Ages a knowledge of its use spread through India, Persia and Arabia, where it is known as ''hashish.'' It is smoked with or without tobacco; it is also made into sweetmeats, combined with honey, sugar and aromatic spices; or it is powdered and infused in cold water, yielding a turbid drink. Generally the first effect of a small dose is stimulating; larger doses produce hallucinations, delirium, sleep, and sometimes catalepsy. During the dreamy state, induced by an average dose of hashish, the patient becomes obsessed with rapidly shifting ideas. Errors of perception as to time and place are a conspicuous characteristic of its effects on the mind. Assassination is historical in connection with hashish, as during the rule of the Ismaelites in the eleventh century, certain selected young men were made intoxicated by hemp, in order to force a condition whereby they were liable to commit any suggested cruelty or murder.

Hemp is still very largely used in Eastern countries as an intoxicant and narcotic, probably by nearly 300 millions of the human race, who are thereby kept practically in a state of slavery by their European rulers.

TOBACCO

Tobacco has been used as a sedative or narcotic over a larger area and among a greater number of people than any similar substance—opium ranking second, and hemp third.

Tobacco was used by the inhabitants of the West Indies long

before Columbus discovered the Western Continent. It belongs to the family of deadly nightshade, and is now cultivated for its leaves, which, when cured, are used for smoking, chewing, and as snuff. Its generic name, *nicotiana tabacum,* was given in honor of Jean Nicot, who introduced tobacco into France from Spain in the middle of the sixteenth century. From France it was taken to England by Sir Francis Drake. Its use rapidly extended throughout Europe and soon became extensively prevalent among Oriental nations.

On the North American Continent the cultivation of tobacco began shortly after the landing of the first immigrants. The first plantings were made in Virginia in 1615, and rapidly extended into Maryland, the Carolinas, Georgia, and later, Kentucky, where tobacco has constituted one of the leading crops ever since. Wisconsin, Ohio, Connecticut, Tennessee and Florida and other Southern States also produce their share of tobacco now. Altogether the United States of America produces more tobacco than any other country—about 35 per cent of the world's crop, one-third of which is exported to European countries. About 1,600,000 acres are now devoted to tobacco culture in the United States, which produces about one billion pounds, valued at one hundred million dollars. In addition to being the largest producer of tobacco, the United States is also the greatest exporter, importer and consumer of tobacco. India is the second largest producer, consuming most of its product; Russia is the third. Brazil leads among the South American countries. Tobacco is also an important crop throughout central and southern Europe, Mexico, Japan and the East and West Indies.

The most characteristic constituent of tobacco is nicotine, a poisonous alkaloid, which is split up during the process of smoking into pyridine and collodine.

Like alcohol, opium, coffee, tea, etc., tobacco must be ranked as a nervous stimulant which seriously interferes with the oxidation and formation of the living tissues, and is especially injurious to the young, leading to impairment of growth, mental precocity, and ultimately resulting in early physical and mental decline. It affects the ganglionic cells, between the center of the sympathetic nervous system and the heart, thereby inducing depression and acceleration of the heart's action, and constriction or dilation of

the blood vessels. The inveterate smoker is often afflicted with what is known as a "tobacco heart." Naturally, there are people who have used tobacco more or less generously and at the same time have attained a ripe old age, but in those instances it will be found that they have inherited a large amount of vitality, and were for the most part abstemious eaters, and seldom indulged in excesses of other kinds. This, however, constitutes no valid justification for the unrestricted use of tobacco. Besides we should take into consideration the fact that several billions of dollars are annually spent throughout the world for tobacco in its various forms. Whatever may be said in its defense, its most ardent advocates seldom, if ever, attribute constructive properties to the narcotic. Of course a certain amount of temporary pleasure can be obtained by the absorption of many substances which are antagonistic to the principles of life, and this pleasurable feeling lasts just as long as our constitution remains in a strong enough condition to resist them, whether they are derived from alcohol, opium or tobacco. As a matter of fact, these temporary, agreeable sensations are really the reaction of the vital organs, the sudden quickening of organic functions, to call upon reserve forces, and this undue stimulation is always followed by a period of mental and physical lassitude.

It is but rational to preserve our vital forces as much as possible, and not dissipate them by indulging in injurious luxuries, although there are many who claim that the use of tobacco has become a comfort and a necessity.

It may be surprising to many to know that the consumption of cigarettes has increased from 25 billions in 1916, to 50 billions in 1921, an increase of 100 per cent in 5 years.

The cultivation of tobacco should not be encouraged from another point of view. It exhausts the soil by depleting it of valuable mineral elements. Many fertile fields have been ruined by tobacco culture. Every four pounds of perfectly dry tobacco leaves contain one pound of mineral matter which we can easily notice in the amount of ashes of burnt cigars and cigarettes. All these substances have been derived from the soil in which the plant has grown and which could have been far better utilized by the cultivation of fruits and vegetables.

PEPPER AND CLOVES

Pepper *(piper negrum)* comprises a family of climbing shrubs which are indigenous to the East Indies, but are now cultivated in most tropical countries. Their fruit, especially the black pepper, is the most common and largely used of all spices. Pepper was known to the ancients, and Hippocrates used it as a medicine. During the Middle Ages pepper was one of the most costly spices, used only by the rich. Pepper depends for its properties chiefly on an acrid resin and acrid volatile oil; it also contains a poisonous alkaloid, piperidin, and a crystalline substance, piperin. Pepper irritates the digestive and urinary tracts. The Hungarian Red Pepper or paprika and the Cayenne Pepper are made from the ground pods of various species of the capsicum plant. The cayenne of commerce is derived from tropical spices, its peculiar pungent taste is due to the presence of a large amount of alkaloid known as *capsicin,* which makes it even more injurious than the black pepper.

Another well-known spice frequently used is cloves, really the dried undeveloped flowers of the evergreen clove tree, which is cultivated in Brazil, Ceylon, India, the West Indies and other tropical countries. When the green buds begin to turn red, they are gathered in the sun. The strong, pungent odor is due to an essential oil, of which 10 to 20 per cent is present. The astringent taste is caused by a large amount of tannin.

CINNAMON AND CASSIA

Cinnamon is the bark of the cinnamon tree *(cinnamomum zeylanicum),* which is cultivated in the islands of Ceylon, Sumatra, and Java, as well as in some parts of tropical Asia. The thin, inner bark of the tree is used commercially in long cylindrical rolls of a light brown color.

Cassia, which is often mixed with powdered cinnamon, is the bark of a tree *(cinnamomum cassia)* which grows in tropical China and India. As the outer bark is usually left on, this product is thicker and darker than the Ceylon cinnamon.

The sweet flavor of cinnamon is due to the presence of from 1 to 2 per cent of volatile oil, while the bitter after-taste is caused by a small amount of tannin contained in the bark.

NUTMEG AND MACE

Nutmeg and mace are products of the nutmeg tree *(myristica fragrans),* which is a native of the East India Islands, but is also cultivated in India and Central America. The nutmeg of commerce is the kernel of the fruit of the tree. The kernel, which is surrounded with a thick covering, is dried in the sun or by artificial heat. In the drying process the outer covering separates and is then ground up into powder. Nutmeg contains about 4 to 12 per cent water, 55 per cent protein, 30 to 40 per cent starch, 30 to 37 per cent fat, 7 to 10 per cent crude fiber, 2.5 to 4 per cent of a volatile oil, and 2 to 3 per cent of mineral water.

Mace is made from the second coat or aril covering the nutmeg, which it resembles in quality.

ALLSPICE AND MUSTARD

Allspice or pimento, as distinguished from pimiento, is the dried fruit of an evergreen tree *(pimenta officinalis)* which grows in the West Indies, but is also cultivated in the East Indies. The berries have a fragrant odor, supposed to resemble a mixture of cloves, cinnamon and nutmegs, hence the name ''allspice.'' Its principal constituents are protein, starch, tannin, crude fiber, mineral matter, and a volatile oil, which produces its characteristic flavor.

Mustard *(sinapis arvensis)* is the seed of the mustard plant, which is cultivated extensively throughout the United States and Europe. There are two varieties known as yellow and brown mustard, which are ground into flour after a considerable amount of the fixed oil has been removed, while a volatile pungent oil, giving this spice its peculiar properties, remains. The mineral matter of the flour consists largely of phosphate of potash and magnesia, lime, and sulphur.

SALT

Table salt (or chloride of sodium), as it is found in nature, either in solid form or as a constituent of sea water, is an inorganic compound containing about 60 per cent chlorine and 40 per cent sodium. It is gained from sea water by solar evaporation, or extracted from the many salt deposits throughout the world. Its consumption is continually increasing, and in the United States about 90 pounds per capita is used annually, or about 4 ounces

per day for every man, woman and child. Salt is used extensively in the meat packing business, the manufacture of dairy products, in bread making, and in the preparation of nearly all cooked dishes.

There is no doubt that salt has been used by man for thousands of years, wherever it was obtainable, but the antiquity of a custom —as previously stated—does not justify it by any means. The salt eating habit was very likely acquired when man began to cook his food, and then tried to restore its palatability. Nature provides man in the natural raw foods with all the mineral elements in a highly organized form, in which they are readily assimilated. Table salt is an inorganic substance and cannot be utilized by the body in the formation of blood or tissues, but is discharged again in the same form, as salt, after having irritated the mucous membranes of the digestive canal. The widespread opinion that salt is necessary as an aid for digestion and the preservation of health, cannot stand in the light of thorough scientific investigation. Experiments have shown that table salt interferes with the absorption of the chyme by the mucous membranes of the stomach and intestines; that it is a strong diuretic, detracting from blood and lymph the necessary water for its excretion through the kidneys; that it unduly increases the solubility of protein, thus excreting in the urine a considerable amount of tissue building material, a pathological condition known as "albuminuria." The continued use of much salt will cause a severe affliction of the kidneys—nephritis. Salt likewise causes inflammatory swellings of the glands; scrofulous conditions are generally observed with salt-eating children; skin diseases (eczema), scurvy, are also common with those who constantly use salt. Smoked meats, dried fish, butter and cheese are especially heavily salted, and the increasing consumption of alcoholic beverages may be largely attributed to this fact.

So depraved has the appetite of many people become that they use salt on almost everything they eat. While very small quantities of salt may not to any appreciable extent be harmful, there are many people who use no salt at all and are much healthier for having discarded it.

Commercialism has evidently a great deal to do with the increasing consumption of salt, as it has been brought within the

immediate reach of every one. It is found on every table, where it is a constant temptation for many to use it excessively.

It is often pointed out that animals increase in weight if salt is mixed with their feed. This, however, is due to an undue stimulation of the appetite, which leads the animals to overeat. The so-called salt-licks are often mentioned as an argument in favor of the use of salt. Close observers found, however, that herbivorous animals crave for salt only as a temporary physic, after they have been deprived of their natural food during the long winter months. As soon as they have a plentiful supply of green foods they will abandon the licks. Likewise man, after adopting a simple and natural diet, will gradually lose his unnatural craving for salt.

VINEGAR

Vinegar is a liquid containing acetic acid in various degrees, usually from 2 to 5 per cent. It is the result of acetic fermentation of alcoholic liquids, such as fermented malt liquors or fruit juices, preferably cider. During the process of fermentation, which is caused by bacteria and is accelerated at temperatures from 65° F. to 75° F., 100 parts of alcohol are converted into 120 parts of acetic acid, which is chemically oxidized alcohol. Although vinegar is one of the oldest and most common condiments and household preservatives, it is, like alcoholic beverages, positively injurious to the digestive organs. It reduces the number of the red blood corpuscles and retards digestion and assimilation. Besides vinegar is apt to be adulterated with sulphuric and sulphurous acids.

Condiments, such as salt, pepper and vinegar, are doing a great deal of harm in the preparation of foods, causing indigestion, and spoiling the taste for the delicate flavor of natural foods. The natural fruit acids of the lemon and lime should always take the place of vinegar, for these acids benefit health and vitality.

CHAPTER XI

Adulteration of Food and Drink

It should be the highest aim of the farmer and manufacturer to furnish to the consumer the best and most wholesome foods which experience and skill can produce. Our present system of commercialism, however, has developed the tendency to put the quick and unscrupulous acquisition of wealth before public health, giving the latter problem only secondary consideration or disregarding it entirely.

There are many staple foods on the market, which, according to prevailing standards are quite legitimate, such as white flour, corn syrup, candies, crackers, various canned and preserved foods, sulphured fruits, highly seasoned foods, and many other widely advertised products which cannot be recommended from a hygienic standpoint. Most of these foods are deficient in organic salts and vitamins, while substances have been added which are more or less detrimental to health. The only protection left to people against the constantly increasing varieties of manufactured foods is to inform themselves about the real nutritive and hygienic value of what they eat and drink, and to disregard the exaggerated claims made by imposing advertisements in magazines and newspapers. The American people, metaphorically, have been educated "to eat with their eyes." Products that have been bleached until they have lost all traces of their original color, or that have been colored with brilliant dyes, are generally given the preference, irrespective of their inferior nutritive value. To educate the people to a better understanding of true food values should be the aim of all public and domestic science schools, colleges and universities, but most of the text books used in these institutions merely confirm belief in the harmful methods applied at present to the manufacture and preparation of foods.

Adulteration of foods and drinks, as generally understood, includes a number of injurious and deceptive practices. According to existing laws, food is regarded as adulterated if anything has been mixed with it to reduce its quality or strength, if anything

inferior or cheaper has been substituted wholly or in part; if it consists wholly or in part of a diseased, decomposed, or putrid animal or vegetable substance; if by coloring, coating, or otherwise, it is made to appear of greater value than it really is; if it contains any added poisonous ingredients, which include coloring matter, dyes, chemical preservatives and mineral substances. Misbranding, or mislabeling, also constitutes an adulteration.

All these practices are dealt with in the Federal Pure Food Law, enacted by the Congress of the United States, June 30, 1906, and amended August 23, 1912, and March 3, 1913.

Adulterations usually consist of the addition of cheaper, though harmless ingredients, added for commercial profit, rather than of actually poisonous or injurious substances, though occasional instances of the latter have been found.

Before the passing of the Pure Food Law, the use of chemical preservatives was quite extensive, because it was cheaper to use them than to preserve foods by pasteurization and sterilization, or by refrigeration. In the process of pasteurization, the liquid is subjected to a temperature of about 160 degrees F. for 20 minutes in order to destroy the bacteria of fermentation. Sterilization is employed chiefly in the preservation of canned foods, after the cans have been hermetically sealed. The temperature reaches the boiling point of water, or more, if the cans are sterilized in an air tight cabinet under pressure. This method, however, detracts considerably from the nutritive quality and digestibility of the food, as it coagulates the protein and disorganizes the mineral elements.

Refrigeration, or cold storage, is now the most widely used method of food preservation. The temperature is held constantly below 40 degrees F. to prevent fermentation or putrefaction.

The most commonly used preservatives are sodium chloride, or table salt, saltpetre, nitric acid, boron compounds (borax and boric acid) formaldehyde, sulphurous acid and sulphites, salicylic and benzoic acids, fluorine compounds, alum, copper-sulphate, sulphate of lime, formic acid, saccharine, etc. Under the present laws the use of some of these preservatives in small quantities is permitted, provided the amount added is plainly indicated on the package.

The users of chemical preservatives have employed well known experts to testify in favor of these products, in order to belittle their injurious effects. The argument generally made that small

quantities of an injurious substance are not harmful, is wholly untenable. It may be conceded that these minute quantities would not be dangerous in so far as producing any immediate fatality is concerned, but after continued use, they will certainly prove injurious. As in the case of other poisons, because the injurious effects of single doses or small quantities are not traceable at once, affords no proof that the habitual use of preservatives is harmless. It is the constantly falling drop of water that finally disintegrates the rock.

It is evident that any substance which prevents chemical action outside of the body, must naturally interfere also with the work of the digestive juices in preparing food for assimilation. The U. S. Department of Agriculture made a number of experiments to determine the physiological action of some of the most widely used preservatives. The work covered the effect of salicylic and boric acids, saccharine and sulphate of lime upon the salivary digestion of starch. The action of these substances was studied by leaving the starch and saliva in contact with them for different lengths of time, the periods being 1, 5, 15, 30 and 60 minutes.

The conclusion drawn from the results of the experiments are as follows:

When the preservatives are present in the proportion of 1 part to 210 parts of food, the entire action of the saliva is, without exception, suspended for five minutes. At fifteen and thirty minutes borax still impedes the action; even at sixty minutes the digestive action is still checked slightly by borax. At the end of sixty minutes in the experiments with salicylic acid and saccharine, not a trace of sugar could be found. These results show that salicylic acid is the most injurious of this group of preservatives. Saccharine comes next, followed by borax and sulphate of lime.

Sodium chloride, or common salt, is one of the oldest preservatives. Before the introduction of borax and boric acid it was used in much larger quantities for this purpose than at present. Butter often contained from 6 to 8 per cent of salt, while now from 2 to 3 per cent is used. The effect of salt on the human system has been described in the preceding chapter.

Saltpetre *(potassium nitrate)* is largely used in salting meats. It is apt to produce nausea, vomiting, and diarrhoea, and, when used in large doses tends to inflame the urinary passages, and to

irritate the epithelium of the mucous membranes. Like common salt, saltpetre has been largely displaced by borax as a preservative.

Boron, in the form of borax and boric acid, or a mixture of the two is probably now the most commonly used preservative, especially in the preservation of meat, fish, fats, and to some extent, of fruit juices and condensed milk. All boric compounds have the property of paralyzing fermentative action and thus securing immunity from decay. Borax has a stronger action than boric acid. Dr. Harvey W. Wiley, former chief of the Bureau of Chemistry, U. S. Department of Agriculture, who made some elaborate and extensive series of experiments with boron compounds, came to the conclusion that both boric acid and borax, when continuously administered in small doses for a long period, or when given in larger quantities for a short period, create disturbance of appetite, of digestion.

The Prussian Scientific Deputation on Medical Conditions, in a written opinion, on the request of the President of the Berlin Police Service, also decided against the use of boron preparations for the preservation of foods, because it was found that these substances, even when taken in small quantities, are injurious to the human body. By the addition of these preservatives, the public is deceived as to the inferior quality of adulterated foods. Decayed and wholly unedible flesh products, for instance, take on a fresh appearance as a result of the addition of borax compounds.

Salicylic Acid is a white, crystalline, strongly acid powder made synthetically by treating carbolic acid with sodium hydroxide and carbon dioxide; it is also procured by treating wintergreen oil with strong potash lye. Salicylic acid is slightly soluble in cold water (1 part in 450) and much more so in hot water. It is readily soluble in ether, alcohol, and chloroform. It is also frequently found in very diminutive amounts in grapes, strawberries, and other fruits.

Salicylic acid prevents fermentation of fruit juices, if added in the strength of one per mille. It is a powerful drug which acts as an irritant in its passage through the kidneys, producing albuminuria and even haematuria; it also exerts a depressing effect on the heart. Its use in food products has been prohibited in France and Germany.

Dr. Wiley's investigations also show that the use of salicylic

acid and sylicates is injurious to the digestive processes and though not always immediately apparent, must finally produce serious effects upon health.

Benzoic Acid, which resembles salicylic acid in chemical composition, is produced by the oxidation of a large number of organic substances, particularly resin, which exudes from the bark of trees growing in Java, Sumatra, Borneo, and Siam. It is odorless when cold; and is soluble in 200 parts of cold and 25 parts of boiling water, and readily dissolves in alcohol.

Sodium Benzoate is the salt most largely used in commercial preservatives, being much more soluble than benzoic acid, into which, however, it is converted when added to acid fruit preparations. Benzoate is a white amorphous substance, having a sweetish, astringent taste, and is soluble in 1.8 parts of cold water, and in 45 parts of alcohol. It is largely used as a preservative of catsups, fruit products, soft drinks, wines, fish, butter, and sometimes in milk. Its use is permitted under the federal law, provided the presence and amount are declared on the label. But since many people are not acquainted with chemical terms, the notice does not materially affect the sale of the product.

Dr. Harvey Wiley found, after a careful study of many individual cases, that the administration of benzoic acid and benzoate of soda was attended with a distinct loss of weight, indicative of either a disturbance of assimilation or an increased activity in those processes of the body which result in destruction of tissue. While the administering of both these preservatives, therefore, is undoubtedly harmful, the injurious effects are produced more rapidly with benzoic acid than they are with benzoate of soda. The final results, however, show that the total harmful effect is practically the same in both cases. There is no reason for assuming that the administration of the preservative in the form of benzoate of soda can have any other than a deleterious effect upon the body. In the interests of health, both benzoic acid and benzoate of soda should be excluded from food products.

Fluorine Compounds possess marked preservative properties. They are used to a small extent in the preservation of dairy products and beer. Experiments have proven that fluorides, even in small quantities, have injurious action upon protoplasm. They reduce the force and frequency of pulsation and depress the temper-

ature of the body. They also decrease the number of red blood corpuscles.

Alum is not generally considered to be antiseptic, but it is a constituent of certain preservatives sold for curing meats. It is also used to harden vegetables for pickling, and in baking powders to improve the appearance of bread. Although it may not do immediate harm in minute quantities, it is dangerous, and its use in foodstuffs should be entirely discontinued. In Germany, the use of alum in the manufacturing of food products has been strictly forbidden for many years.

Copper Sulphate and salts of copper, are used more for coloring purposes than for preserving. The copper forms with certain proteids a compound possessing a dark green color, which adds to the appearance of preserved peas, string beans, and other vegetables. The copper salts also harden the exterior covering of peas, so that when preserved in bottles or tins, the vegetable remains intact and the surrounding fluid clear. The skin of peas not treated with copper easily breaks apart, and the fluid becomes turbid although the peas remain in good condition.

Sulphate of copper has been used in the United States for the destruction of algae in water reservoirs, and according to experiments the sulphate in dilutions of 1 in 10,000,000 to 1 in 50,000,000 was sufficient to kill the algae. Copper sulphate added to water in this manner seems to disappear on standing, apparently it is precipitated as a carbonate, or as an organic compound which settles on sedimentation. In any case, the quantity used for the prevention of vegetable growth in water is exceedingly small as compared with the amount contained in peas and other vegetables treated with copper. As water, however, is used in large quantities every day, the question whether traces of copper contained therein are likely to endanger health is an important one.

Experiments with men and animals have shown that an amount of copper sulphate of more than 2 grains per day, taken by an adult man, is decidedly injurious to health, and where the above quantity is exceeded, symptoms of poisoning appear. In some of the European states, the use of copper salts is prohibited, while in the United States they are permitted, provided the amount is given on the label.

Formic Acid is a colorless liquid at temperatures above 50 degrees F. It boils at 214 degrees F., has a pungent odor and strong caustic action when applied to the skin, causing pain and ulceration. It occurs naturally in the bodies of ants and bees and in small quantities in various vegetable and animal substances. It is closely allied to acetic acid, but seems to be more powerful as a preservative. A water solution containing less than one per mille will entirely prevent the growth of yeasts and bacteria. A 60 per cent solution of formic acid is generally sold for preserving purposes, but its use is objectionable, as even small doses continuously used will produce irritation of the stomach.

Saccharine is a white powder, composed of irregular crystals whose melting point is above 440 degrees F. It is soluble in 230 parts of cold water and 30 parts of alcohol. Its aqueous solution is distinctly acid in reaction. Its antiseptic properties are about equal to those of boric acid. The use of saccharine in foods is not allowed under the federal law, as it has been found that quantities over 0.3 grain or one grain per day used for a considerable time were apt to produce digestive disturbances. While the use of saccharine in foods is allowed in certain disease, like diabetes, there is absolutely no reason to give such preparations to patients, as they work irreparable injury. A faulty metabolism will not be corrected by simply withholding the natural sugars and giving artificial sweets instead, as only a sufficient supply of alkaline elements in foods will aid in restoring the natural function of the digestive organs.

Saccharine, besides being a preservative, belongs to the intensely sweet coal-tar derivatives that in themselves possess no food value whatsoever. This high sweetening power, in some cases several hundred times that of cane sugar, makes it possible for minute quantities of the substance to impart an appropriate degree of sweetness to food products. Commercial glucose, which is considerably less sweet than cane sugar, is often used instead of the latter in the preparations of jellies, jams, preserves, etc., to which a very small quantity of saccharine is added to increase the sweetness of the product that would otherwise have a bland taste. Canned vegetables, such as sweet corn and peas are occasionally treated with saccharine, especially if their sweet, fresh taste was partly lost before canning. The addition of one part of saccharine

to 1,000 parts of commercial glucose makes the latter as sweet as cane sugar.

Formaldehyde, which in its pure state is a gas, is usually sold under the name of "formalin," which consists of a 40 per cent solution in water or dilute alcohol. For the preservation of milk it is frequently used in a weaker solution, about one per cent. If exposed to the air, it readily undergoes oxidation into formic acid. Some of its properties are its power to harden protein, and its retarding action on the various digestive ferments. Even when highly diluted, formalin has a more deleterious effect in the digestive processes than boron compounds. Formalin is now used by undertakers for embalming purposes.

Sulphurous Acid is chiefly employed as fumes of burning sulphur, applied either to the food products themselves in the course of manufacture or to the containers in which the food products are held. When sulphurous acid is used as a preservative for food products, it is usually employed in the form of bisulphite of lime, or some similar preparation.

Despite all the efforts of Dr. Harvey W. Wiley to have the poison prohibited, the advocates of food preservatives have been partially successful, having secured permission to use sulphurous acid, upon the condition that they print a notice to that effect on the labels of products containing it. As a rule very small type is used, so that the printed notice escapes the eye of the consumer, who, in most instances, is ill informed about the real effect of preservatives. Dr. Wiley, with the collaboration of W. D. Bigelow, F. C. Weber, and others, has made very extensive and painstaking investigations to determine the effects of sulphurous acid and sulphites on digestion and health. The findings have been published in Bulletin No. 84, Part 111, U. S. Department of Agriculture, Bureau of Chemistry, from which the following data, in part, are taken:

In the technical use of sulphurous acid in the manufacture of food products, only the fumes of burning sulphur are employed. Fruits, pared or unpared, are subjected, after the removal of the pit or core, to sulphur fumes in what is known as a "sulphur box"; similarly in the manufacture of syrups and molasses it is not unusual to expose the freshly made juice of the sugar-cane to the fumes of burning sulphur. The "sulphur box" used in this case is so constructed that the juice falling over shelves by gravity

absorbs the fumes of the burning sulphur rising from the box, which serves as a chimney. The sulphur dioxide becomes incorporate with the components of the juice, forming more or less stable compounds which are not entirely broken up by subsequent boiling. When sugar is made there is a concentration of the sulphur compounds in the molasses and this concentration becomes greater in proportion to the amount of sugar crystals removed. In the low grades of molasses sulphur is found naturally in extraordinarily large quantities. In the preparation of dried apples, apricots, peaches, peas, raisins, figs and many other light-colored fruits, sulphuring is practiced for the following reasons:

1. To produce as clear and intense a yellow or whitish color as possible.
2. To conceal decayed portions of the fruit which have been overlooked in the trimming.
3. To prevent fermentation and decay during the drying of the fruit.
4. To protect the fruit during drying, from flies and other insects, the larvae of which would otherwise develop after the fruit was stored.
5. To kill the cells of the fruit, and thus make the texture more porous, which expedites drying.

It is a well-known fact that highly sulphured fruits are preserved with a lower degree of desiccation than those not sulphured, because a greater weight of fruit is produced from a given weight of the raw material when sulphur is used. It is not difficult to preserve a water content of 30 per cent.

The only arguments of any force favoring the use of sulphurous acid in food products are those which relate either to the preservation of the fruit or to its color. As the proper preservation of the produce can be easily secured with only a slight change in color, these arguments cannot justify the continued use of sulphurous acid and sulphite, which never add anything to the flavor of foods, but render both less palatable and less healthful. All sulphur compounds produce an injurious influence on the metabolism of the body. They add an immense burden to the already overworked kidneys, which are called upon to remove nearly all of the added sulphur previously converted, to an appreciable extent, into sulphuric acid.

Another effect which the use of sulphured foods produces, and one of even more serious character, is found in the impoverishment of the blood in respect to the number of red and white corpuscles contained therein. The use of a substance which interferes with development of these important component particles of the blood must be regarded as being highly prejudicial to health. The evidence all points to the fact that sulphur compounds are purely drugs, exerting deleterious and harmful effects upon the metabolic processes.

With the improved methods of fruit and vegetable dehydration in which temperature, moisture, and air currents can be perfectly regulated, as shown in Chapter VIII, there remains no excuse for the production of sulphured food products, except to satisfy an artificially created demand for light colored foods and to comply with falsely established commercial standards.

Unsulphured dehydrated fruits have a better flavor and are sweeter than the highly sulphured products which should be avoided both from the standpoint of health as well as economy.

Artificial Food Colors may be divided into animal, vegetable, mineral, and synthetic coal tar dyes. Their use has greatly increased during recent years. Vegetable and mineral colors have been largely displaced by coal tar or animal colors, which are now used extensively in the preparation of foodstuffs and drinks. Here again the consumer has been misled by the creation of a false standard. The attractive coloring of jellies, jams, ketchups, soft drinks, etc., mislead the public into thinking that the genuine products are inferior, and establish a demand for unnaturally colored varieties. With a few exceptions, coloring matters in food are used to deceive the public as to the true character of the articles sold. The intelligent consumer should object to the use of coloring matter in foods, not only from the standpoint of health, but also for economic reasons, for the goods are made to appear of greater value than they really are.

Various countries have enacted specific laws regulating the use of coloring matters in foods, especially England, France, Germany, Austria and Italy. In the United States no coloring matter is to be used unless each package is marked "artificially colored."

One of the principal animal colors employed is *cochineal,* consisting of the dried bodies of insects living on the cochineal fig—

a species of cactus, cultivated in Mexico, Central and South America, especially for the sake of the cochineal insect. It is used in ketchups, cordials, confections and other food products.

The principal vegetable dyes used are annatto, turmeric, camwood, logwood, saffron, carrot juice, indigo and gamboge. Annatto has been principally used by dairy farmers for butter. It is an extract from the red pulp which covers the seeds of a South American tree, *bexia orellana,* is usually sold as aqueous extract, or dissolved in cottonseed oil, and has also been used for the coloring of margarine.

Turmeric is extracted by alcohol from the root of rootstock of an East Indian plant, *curcuma-longa.* It is of a brilliant yellow or saffron color, has a slight aromatic odor, and a bitter, slightly acrid taste.

Logwood is the heart-wood of a South American tree. It is a red, heavy wood, containing a yellow, crystalline coloring matter; camwood, which is similar to logwood, is the product of a West African tree.

Saffron is a bulbous plant, whose deep yellow flowers are used in the preparation of a yellow color of the same name. It is often used for coloring cakes and pies to give them a richer appearance, suggesting the plentiful use of eggs.

Carrot Juice is frequently employed for coloring butter and margarine.

Indigo is a blue coloring matter obtained from the tropical plant *indigofera tincteria,* and is formed by the decomposition of a peculiar substance called *indican,* which exists in the juice of the plant. Indigo is obtained by steeping the plant in water till the indican is decomposed by fermentation, when the coloring matter is precipitated in the form of a blue sediment which forms the indigo of commerce. It assumes a coppery luster by friction with a hard body, is lighter than water, and insoluble in it, and is, therefore, suited only for solid foods. It has been used for coloring confectionery, unroasted coffee and tea. With concentrated sulphuric acid the dry material becomes yellowish, changing slowly to blue-green.

Gamboge is a condensed juice, or gum resin, produced by several species of trees growing in Siam, Ceylon and Malabar. It is brought in bulk, or cylindrical rolls from Gambogia, whence its

name. It is of a dense compact texture and a beautiful reddish-yellow. Taken internally it acts like a strong cathartic.

Mineral dyes have been mostly replaced by anilin dyes, with the exception of copper sulphate and oxides of iron, the former being practically the sole substance used for preserving the color of green vegetables, as none of the newly discovered dyes have been found to produce the desired effect. Formerly the use of such pigments as chromate of lead was common in coloring confectionery, but their use has been almost entirely abandoned.

Other mineral substances unfit for use in food on account of their poisonous effects are those which contain salts of arsenic, mercury and lead. Chloride of tin was at one time extensively used to neutralize the natural color of beet sugar, causing it to resemble Demerara Sugar, thus fraudulently increasing the commercial value of the former.

Ultramarine is a blue pigment originally obtained by powdering an aluminous mineral (lazuli) of a rich blue color. It was so called because the mineral was originally brought from Asia. Granulated sugar is usually treated with a weak solution of ultramarine to remove the natural yellow color.

Prussian Blue (cyanide of potassium and iron) is a salt of a beautiful deep blue color, and is often used with ultramarine for coloring tea. The Chinese and Japanese are careful not to color the tea which they themselves consume, but only that intended for export. In Europe, where a great deal of coffee is sold unroasted to the consumer, most of the cheaper grades of coffee are colored by putting the beans in a revolving drum and adding some finely powdered coloring matter.

Coal Tar Dyes are the most extensively used for all artificial colors, since their production has been perfected. They are practically unlimited in variety, and are chiefly sold in the form of powders. The water soluble varieties are readily made into solutions for food colors, while the insoluble forms are mixed into pastes. The soluble dyes are used in the manufacture of confectionery, soft drinks, jellies, jams, meat, especially sausages, dairy products and wines. Oil-solutions of coal-tar dyes are also employed for coloring butter and margarine. Pastes made from insoluble dyes are adapted mainly for exterior coatings of hard substances such as candies. The quantity of dye is generally very small, rarely

exceeding 1 part in 1,000 and being often less than 1 part in 10,000. Coal tar dyes are permitted under the Federal Law, but the use of any dye, harmless or otherwise, to color food in a manner whereby damage, or inferiority is concealed, is in violation of Sec. 7 of the Foods and Drugs Act of June 30, 1906. The addition of all mineral or metallic dyes, and all coal-tar dyes, other than those specially provided for, is also prohibited. Although it is claimed that some of these dyes are added because of purely aesthetic consideration, it should be every intelligent housekeeper's duty to stop the practice of coloring food, by refusing to buy such articles, for all artificial dyes, if taken internally, are harmful.

Coal tar dyes are also largely used in the concoction of imitation fruit juice beverages with which the market is flooded today, and the consumption of these products has naturally increased very greatly since the passing of the Volstead Act. According to W. W. Skinner, Chief Chemist of the Water and Beverage Laboratory, U. S. Bureau of Chemistry, there are over 12,000 bottlers of beverages in the United States, doing an estimated annual business of approximately $150,000,000, and this does not include soda fountain beverages. The larger demand for real fruit juices has led to the development and sale of many imitation products, flavored either with essential oils, or extracts made from them, or largely from synthetic products, but which, in order to take advantage of the growing popularity of fruit juice products, are advertised in a very deceptive manner. These advertisements either claim or imply on the label, or in the advertising matter of bill boards, that the product is made from whole ripe fruit.

This deception has been practiced to such an extent that the Bureau of Chemistry has issued the following new ruling in 1920:

"Terms, such as 'ade,' 'squash,' 'punch,' 'crush' and 'smash' can be applied properly only to beverages, either still or carbonated, which contain the juice or edible portion of a fruit. These terms should not be applied to products flavored only with essential oils or essences unless plainly labeled as imitations. . . . It is further held that any turbid or 'cloudy' orange or other fruit flavored beverage, which does not contain either an appreciable quantity of the juice or edible portion of orange or other fruit named, should be labeled plainly as an imitation."

Many of the so-called fruit drinks are made from concentrates or syrups manufactured by producers in some of the large cities.

These concentrates or syrups may be made from fruit juice or pulp—which may constitute as much as 50 per cent of the product—but this syrup may be so fortified with essential oils or extracts that when the bottler gets it he simply dilutes it with plain syrup to such a degree that if it is added at the rate of one ounce to the bottle of the finished beverage, the original fruit juice has been so diluted that it has almost disappeared.

All so-called soft drinks containing cane sugar syrup and artificial coloring matter are decidedly unwholesome. Fresh or pasteurized fruit juices should always be given the preference, but they must be sipped slowly, as they are really liquid foods.

Metallic Impurities, especially the salts of lead and tin, are commonly found in varying amounts in nearly all classes of products put up in tin. The quantity dissolved depends largely on the character of the tin plate used in the manufacture of the can, also on the nature of the food product and its acidity. Although the quantities of metal dissolved are small, yet the basic action of even a diminutive amount of lead salts is well known. The universal use of tin cans has led health authorities to closely watch for excess of tin and lead from careless soldering, with the result that today only the best quality of tin and lap solder on the outside are found on standard goods. The danger from the solution of tin and lead is of course much greater when canned goods are regularly used, as for instance in mining camps, or on board sailing vessels. Unsulphured evaporated fruits or vegetables should always be given the preference.

The bleaching of flour is done chiefly for the purpose of satisfying an unjustified demand for snow white flour. Bolted flour is bad enough but by placing bleached flour before an unsuspecting public, the millers have simply further lowered the value of their product from a hygienic point of view. During the World War people were compelled to live on all kinds of unbolted flours, middlings, etc., in order that more of the supposedly more nutritious white flour could be shipped to the armies in the field. At that time many people found out, much to their surprise, how much more satisfying and wholesome the darker looking whole wheat products are.

However, the bleaching of flour is still practiced; evidently the majority of consumers cannot yet adjust themselves to the darker

looking, but more nutritious unbolted kinds. According to present standards, the grade or quality of flour is largely determined by its appearance, odor, and color as well as by its fineness, as indicated by rubbing it between the fingers. A very minute amount of nitric peroxide will remove the yellow tint of an inferior grade of flour, so that it can be sold as a much higher grade. The sale of bleached flour is therefore generally held to be illegal.

Before the passage of the Federal Pure Food Law, the larger part of flour produced in the United States was bleached by nitrogen peroxide, but as a result of a stricter enforcement of federal regulations the practice has diminished. The millers still assert that bleaching does not deteriorate the quality of the flour. The gas used in bleaching is generated by electrical, chemical, or electro-chemical means, and is diluted with air before treatment of the flour. In the so-called Alsop Process, which is most commonly employed, it is formed by a flaming discharge of electricity, which causes the nitrogen and oxygen of the air to combine. The yellow tint of the flour is quickly destroyed by the gas, which also forms nitrous and nitric acids with the flour. A considerable part of the nitrous acid remains in yeast bread after baking and nearly all of it in soda biscuit. There is no doubt that bleaching affects the quality of gluten and injures the flavor of bread. It is really a pity to contemplate how the wheat farmers are selling the natural whole wheat to the millers and buying in return a very much devitalized flour, which lays the foundation for many human ills. Small flour mills, driven by electricity, could be easily established in every community and supply the people with really good and wholesome grain flours.

The bleaching of corn by artificial means before canning is usually accomplished by boiling the corn with sodium sulphite, thus giving the product an unnaturally white color. The practice seems to have been more in vogue some years ago than at present, the popular taste now apparently preferring the natural rich yellow corn.

Animal Glue is often used in foods. Americans spend about $250,000,000 annually for ice cream. While some of the better grades are legitimate, and contain the required amount of eight per cent butter-fat, the cheaper grades are abominable concoctions, which are prepared with gelatin or glue.

Alfred McCann, the well known writer, in "Physical Culture Magazine," recently investigated the finest ice cream plant in the state of New Jersey. The ice cream was properly pasteurized and actually contained a minimum of twelve per cent butter-fat instead of the eight per cent required by law. The chocolate flavor was made up of cocoa-powder, the fat of which had been saponified by the chemical action of ammonium hydroxide. Among the fruit flavors were combinations of oenanthic ether, nitrous ether, acetic ether and many other synthetic "fruit essences." While the cream was apparently legal as far as the amount of butter fat was concerned, yet it had, aside from the artificial flavor, another characteristic which it shared with many other kinds of ice cream. It could stand for hours in the sun without melting, because it was "bodified" with glue.

In communicating with the manufacturer, McCann made the following report:

"The stuff they (the packers) make is glue and is intended for commercial purposes only. They declare its legitimate use should be confined to paper box manufacturers, shoemakers, cabinet makers, carpenters, etc. That it finds its way into human food through the instrumentality of jobbers and brokers after it leaves the Armour glue works is an unhappy state of facts for which Armour and Company declare they cannot hold themselves responsible.

"In New York when they receive an order for edible gelatine they are obliged to treat it as a 're-sale' and go out on the market for it as an accommodation to their patrons.

"You can appreciate the rotten significance of this statement of fact. Everywhere I go I find barrels of glue made by the packers. The stuff is being used as 'gelatine' for the frozen dainties sold to children, and in many instances a high price is paid for it, yet packers themselves, when appealed to, denounce its use.

"I suggest that you take steps at once to secure a supply of fool-proof, edible gelatine, free from sulphites, free from arsenic, free from lead, free from zinc, free from gas-producing organisms disclosing the presence of filth; free from gluey flavor and gluey odor. The probability is that when you do this, you will be the only ice cream manufacturer in the whole metropolitan district decent enough to put gelatine instead of glue into your ice cream."

The official records of the New York Health Department reveal that in June, 1921, out of 1,400 samples of ice cream analyzed, 78 per cent were adulterated. Many of the adulterated products

contained as little as two per cent fat. Glue was used in almost every instance.

Director Ole Salthe of the Food Inspection Bureau undertook a series of prosecutions and by December, 1921, he had cut down the adulterations from 78 per cent to 28 per cent. His disclosures show how corrupt and indecent the situation was, while the public had not the slightest suspicion of what was going on. It is said that many of the chocolate covered ice cream bars, now widely advertised, contain a very inferior and deleterious filling.

There is no doubt that multitudes of people, even in the smaller cities and towns, are suffering from impure food, and are looking to the law-makers for protection. It never seems to occur to these people that most of the food eaten should be of such nature, that its wholesomeness should simply be a question of its hygienic preparation from the time of production until it reaches the table.

The ideal way for the solution of this problem is for every family, whenever possible, to have its own little garden and orchard to preserve its own fruit and vegetables, and to use ready made foods only in an emergency. Many of the commercially prepared products may not be distinctly poisonous, but their nutrition and hygienic value have been in most instances greatly diminished and impaired.

CHAPTER XII

Faulty Nutrition and Disease

One of the surprising facts developed by the World War was the alarming condition of our national health. Pressed by the exigencies of our commercial age, we never stopped long enough to take a good look at ourselves, and to find out the real causes of rapidly increasing diseases during childhood and middle age, when the vitality should be at its maximum.

When war was declared by the United States against the Central Powers in the early spring of that memorable year 1917, the American people were given their first opportunity to take a thorough inventory of their state of health. Nearly four millions of men between the ages of eighteen and thirty years were inducted into war service, and in order to secure this force, a very much larger number had to be examined because an astonishing proportion of those of draft age were rejected for serious physical and mental defects. After the first million had passed examination, the large proportion of physically unfit aroused general consternation, except perhaps among the few who understood the causes involved. Equally surprising was the vast number of illiterates discovered.

The reports of Surgeon General Rupert Blue, in the *American Journal of Public Health,* September, 1919; the *Public Health Report of the Treasury Department,* March, 1918, and the *Report of the War Department,* edited by Surgeon General Ireland, in 1920, give some very significant facts.

General Ireland's report is very exhaustive. It deals with nearly three million men, from the ages of eighteen to thirty, the majority approaching the latter age; and enumerates both the defectives and the rejected with their classification. Each of the recruited men passed through the hands of from four to twelve examiners, so that errors and inequalities should be fairly well balanced on the average. It must also be considered that the maximum age of the examined was thirty years, while a larger proportion of men in this country are between thirty and fifty years of age, when the defective conditions of the body, often more or

less latent in early years, begin to reveal themselves. Comparing the cases of heart and kidney diseases of the drafted men with the statistics of the life insurance companies, it appears that the draft examiners found sixteen per cent affected with these diseases while the percentage reported by the life insurance companies was as high as fifty-six.

Of the nearly three million men drafted, about fifty per cent had some serious defects, while a large number had multiple defects, such as diseases of the principal vital organs—heart, lungs, blood-vessels and brain—and diseases that are dependent on lowered resistance, such as tuberculosis.

Men coming from different portions of the United States showed different defects, owing apparently to the habits of the regions where they had lived. The government report summarized these differences, as follows:

"The northeastern part of the country appears to be characterized by congenital defects, and those of city life. The northwest is characterized by deformities due to accidents, by goitre, and by flat foot. The southeast is characterized by venereal diseases, hookworm, and other similar complications, including blindness of one eye, arthritis and ankylosis, underweight, mental defect, emotional disturbances, pellagra, hernia, loss of upper extremity, and bullet or other wounds. The southwest is characterized by tuberculosis, drug addiction, hypertrophied tonsils and hernia. The northern central area is contrasted with the southern central by having more goitre, less tuberculosis, much less venereal disease, more varicocele and more varicose veins, more diseases of the heart and nervous system, and more deficient teeth. It is characterized by more cases of defective eye-sight, diabetes and curvature of the spine."

Another fact has been revealed by the examinations. Certain sections of the country, with occupational or racial peculiarities, show vastly different proportions of defectiveness. In this respect some of the oldest elements of our population have the highest number of defectives. For instance, the Anglo-Saxon colonial type is slowly disappearing, as the result of a deficient birth rate. The French Canadians have a high birth rate and an equally high defective rate, while the Southern States with a large negro population show the largest number of defectives.

California, strange as it may seem, ranks with the states showing the highest percentage of rejected men. This may be ex-

plained by the fact that California serves as a place of refuge for invalids of all kinds. The excessive death rate in some of the California cities is also to be attributed to this condition.

The examination of about thirty thousand school children in San Francisco also revealed some startling facts: 26 per cent were found to be under weight; 38 per cent showed postural defects; 91 per cent had defective teeth; 27 per cent had enlarged tonsils; 25 per cent had adenoids; 7 per cent had anemia. It appears that quite a number of the children were afflicted with several defects. Among the defective children a great number of the wealthier classes were represented, suffering mostly from mal-nutrition. Coffee and toast constitute the breakfast for a large majority of adults, and unfortunately it is also the fare of a lamentably large number of children. This, too, occurs in a state where fresh or dried fruit may be secured every month of the year, but owing to a lack of true education on the part of parents, many of them are afraid to permit their children to have the fruit they naturally crave.

Dr. Clark of the Public Health Service, Washington, who has examined many thousands of school children in different portions of this country, reported that ninety per cent of the school children have from one to eleven cavities in their teeth. It is but natural that bad teeth are accompanied by other manifestations of physical inferiority.

Among nearly 100,000 children in New York City, about one-third were found to have such defective eyesight as to require glasses. In Philadelphia 60 per cent of the children examined showed marked eye-strain or defective vision and 354 pupils were discovered who could not read ordinary writing on the blackboard even at the distance of a few feet, and could only with difficulty make out the print in their books. In Massachusetts, outside of Boston, 20 per cent of the pupils were found defective in vision.

The number of children with defective hearing or diseased ears in our schools is large. Massachusetts reported 27,000 pupils with defective hearing in the year 1907. Investigations in fifteen different cities led to the estimate that nearly 50,000 children in Pennsylvania are unable to reap the full advantage of instruction given, because of defective hearing.

Many dull children are so because the eye or the ear, both avenues for the reception of knowledge, is in a diseased condition. The defects in the senses may and often do exert a baneful influence throughout life but they are not so likely to weaken physical vigor and invite diseases as defects in the teeth.

The reason that we are a nation of dyspeptics lies largely in the fact that children are irrationally fed during school years, which inevitably results, among other evils, in impaired teeth. An examination of 79,000 children in New York Schools showed that 29,386 possessed one or more decayed teeth. In Strassburg, the first city in the world to adopt dental inspection, 97½ per cent of the school children were found to have diseased teeth. Eighty per cent of the children in Great Britain's industrial schools suffer from decayed teeth. In Germany, among 20,000 children between the ages of 6 and 16, 19,000 were found to have caries to a marked degree.

In striking contrast with this pitiful condition of our rising generation is that of the aboriginal tribes of the Pacific Coast from Alaska down to Peru. In the National Museum at Washington there are about four hundred skulls of what we are pleased to call "half-civilized" peoples, dating as far back as the time of discovery of this continent. These skulls exhibit no indication of teeth decay. The teeth and jaws are well developed, and while the teeth show an occasional mechanical injury, there are no signs of caries.

On the other hand, thousands of the North American Indians at present deprived of their hunting grounds and forests, and forced to live on the products furnished by grocery stores, such as canned meats, milled cereals, refined sugar and distilled liquors, are plainly showing signs of physical deterioration. They are gradually dying of tuberculosis, cancer and other diseases of civilization.

It cannot be too strongly emphasized that proper diet in infancy is the most important factor in the preservation of health, as nearly all so-called "children's diseases" are caused by improper feeding. The period of early childhood is decisive for the remainder of one's life, and the amount of vitality necessary to resist injurious influences, aside from heredity, depends largely upon the quality of nourishment the infant receives. "The child is father

to the man," and as the formation of a strong and healthy body is necessary for the development of a strong and healthy mind, the importance of a sound foundation for the growing organism is evident. It is here where prevention of disease must begin, and not in the bacteriological laboratories.

There are about two million babies born in this country every year, and of these approximately one-fourth die under five years of age. About fifty per cent of these deaths occur before the age of one year is reached. We are therefore compelled to acknowledge the loss of one quarter million of newly born children every year, while one-third of the children born do not attain the age of fifteen years.

Infant mortality remains one of the biggest problems that confronts our western civilization. For years it has been the object of serious concern to governments and municipalities not only of this country, but also of France, Germany and England; and yet despite everything that has been done to avert the peril, the total mortality of infants has not appreciably decreased.

Indiscriminate feeding is at the root of this, as well as of most children's diseases. In fact, so appalling is the ignorance of the majority of parents in regard to feeding their children, that if nature had not endowed the growing organism with wonderful powers of resistance, the percentage of deaths would be much larger than it is. As a matter of fact, many children survive despite parental ignorance.

According to statistics, the American people spend for food materials annually about seven billion dollars which are distributed as follows:

Meat, poultry, and fish about	$2,800,000,000	40	per cent
Eggs	400,000,000	6	" "
Milk	500,000,000	7	" "
Cheese	50,000,000	¾	" "
Butter and other fats	500,000,000	7	" "
Grain products	1,000,000,000	14	" "
Sugar, molasses etc.	500,000,000	7	" "
Vegetables, including canned goods	500,000,000	7	" "
Fruits, including canned goods	300,000,000	4	" "
Nuts	50,000,000	¾	" "
Miscellaneous, including spices, condiments, etc.	400,000,000	6½	" "

It should be noted that of the whole list of foods only two

items—fruit and vegetables—supply acid-binding or alkaline elements in sufficient quantity, and these two important items represent only eleven per cent of the total expenditure. Furthermore, vegetables are generally prepared in such manner that they lose a large proportion of their essential organic salts, while with canned fruits, syrup made from refined sugar is added, which impairs the hygienic value of the fruit. Cow's milk is a neutral food, but becomes acid-forming when boiled or sterilized. We know that most of the cereals eaten are demineralized and deficient in vitamins; flesh meat, which constitutes nearly half of the ration of the American people, besides being highly acid-forming contains a large quantity of the waste products of animal life, which overtax the excretory organs and gradually undermine health and vitality.

While the appalling results of these mistakes are often plainly visible, even in early childhood, they make themselves felt more intensely past middle life, giving rise to constipation, gout, rheumatism, liver and kidney diseases, hardening of the arteries, cancer, tuberculosis, etc. Surgical operations to "cure" the effects of years of wrong-doing are not only futile but lay the foundations for chronic disease.

It is but natural that the abnormal condition of the blood, caused by irrational diet, creates a desire for stimulants and narcotics to deaden the effect of the poisons and toxins that are constantly accumulating in the system. Before the passage of the prohibition amendment and the Volstead Act, the American people spent about one billion dollars every year for alcoholic beverages. Despite the efforts to enforce the law, the habits of the people have not appreciably changed, as a similar amount is now probably invested in home brew materials, and other stimulants and drugs. In fact, the grape growers who expected to be financially ruined by prohibition are now receiving higher prices for their grapes than ever before. So great is the demand for wine grapes that the best qualities bring five times as much as the wineries formerly paid.

Tobacco is another big item in our annual expenditures for stimulants:

$800,000,000—for tobacco and snuff
800,000,000—for cigarettes
500,000,000—for cigars.

In brief, over two billions are yearly going up in smoke. The use of tobacco is unquestionably one of the causes of our increasing enervation.

For ice cream and candy, over $500,000,000 are spent annually; for coffee, tea and cocoa, $750,000,000; and for chewing gum, not less than $50,000,000. The products represented by these enormous amounts add nothing to our health and vitality, but could be spent to far better advantage for educational purposes and for bettering our social and economic conditions.

"Civilized" man is digging his grave with his teeth, and to counteract the effects of his perverted dietetic habits he spends millions of dollars for drugs, patent medicines, serums and vaccines. Unless we can change the mode of life that modern civilization has brought with it, and simultaneously alter our economic system, mental and physical degeneration will increase.

The theory that germs cause diseases such as tuberculosis, cancer, etc., cannot stand in the light of reason. The human cell is the result of millions of years of evolution, and has therefore a much higher organization than the so-called germs of disease, which are simply scavengers, feeding only on devitalized and dying cells, the products of waste matter in the system, but never on healthy, living cells, which are impervious to all kinds of bacteria.

It has been wisely said that if the germ theory of disease were true, there would be nobody alive to believe it, since we cannot sterilize the air we breathe. The only method for fighting disease is to increase health and vitality by rational eating and living, but unfortunately this viewpoint has not been given serious attention in our medical colleges. Bacteriology and symptomology still occupy the most prominent places in their curricula. We frequently find that for which we are seeking, and if it happens that we wish to prove a certain germ is responsible for a specific disease, as a rule we find the germ and our discovery is heralded as a great achievement to a credulous world.

The famous physiologist, Rudolf Virchow, once one of the foremost defenders of the germ theory, said in his later years:

"If I could live my life over again, I would devote it to proving that germs seek their natural habitat—diseased tissue—rather than being the cause of diseased tissue."

Despite these facts which should be obvious to every logical

thinker, the majority of medical men are still confounding effect with cause, regarding germs as responsible for disease. They still ignore the fact that pure blood and good circulation, the result of right living, and a cheerful condition of mind—in other words, sound health—are the greatest immunizing factors. Germs are present everywhere and we could not exclude them from our body by the most rigid system of disinfection or quarantine. If the germ of a disease imported into a community were the cause of an epidemic it would never end. Professor Dr. Pettenkofer, of Munich, once swallowed cholera germs before an excited audience without suffering from the least indisposition.

Doctors believe that they can prevent epidemics by vaccination, but this is an assumption which is not based on biological facts, but on very dubious statistics. Epidemics came and went in times gone by, and doctors had nothing to do with their disappearance. The influenza raged several times during the last ten years and defied masks, quarantine, and every other measure that busy Boards of Health could dictate. The germ of influenza has been recently discovered by the Rockefeller Institute and soon mankind will be presented with a new kind of vaccine. Those who want to be vaccinated should follow their inclinations, but those who want to protect themselves by rational living should not be subjected to the dicta of pseudo-science. It goes without saying that in all epidemics most of the disease is psychological—a frenzy of fear resulting from the pernicious activities of interested people.

To-day preventive medicine, as taught in colleges, is no further advanced than it was in the time of the barber Jenner, who in the year 1770, when nothing was known about physiological chemistry, studied surgery and pharmacy in London. Jenner, while interested in the drug called "theriaca," learned that it had been prepared by King Mithridates VI, who, being of a suspicious turn of mind lived in constant dread of being poisoned. He wanted to counteract any attempt which might be made against his life by systematically inuring himself to poison, and so compounded "theriaca," taking it regularly in increasing doses. Such a story when once heard is never to be forgotten. Jenner did not forget it. While he was earning his living in Berkeley, England, by bleeding, by applying leeches, and by cupping, a farmer's wife

told him another story. She said to him that milking cows which had cowpox on their udders was a good thing to prevent smallpox. Her milkmaids after such milking had an eruption similar to cowpox, but she maintained that they never afterward became afflicted with smallpox.

These two stories suggested to Jenner the remarkable medical system of inoculation with virulent poisons as a means of inuring the body against infection, and today orthodox medicine is still following in his footsteps. After a century and a half of marvelous advancement in chemistry and physiology, we still find thousands of blind followers of a blind leader whose theories are on a level with the proponents of witch burning in the middle ages. Medical science, armed with microscopes and chests of re-agents, discovers germs and bacilli, invents serums, vaccines and anti-toxins, and still remains oblivious to the great truth that the real and ultimate cause of disease is beyond the reach of the microscope and scalpel.

The Vaccination Inquirer of London, England, recently published the following significant statement:

"Cases of smallpox reported in the Philippines during 1918 total 47,369 of which 16,447 died. Manila, the most thoroughly vaccinated place in the islands, had the highest mortality—65.3! While Mindanao, the least vaccinated had the lowest—11.4 per cent.

"We have never before, on a large total of cases, heard of such a fatality as 65.3 per cent. Considering that the sanitary engineers had been busiest in Manila; considering that they had an up-to-date 'scientific' medical staff, and considering the pre-Jenner mortality of smallpox only averaged 18 per cent, it will tax even medical ingenuity to explain away that shocking figure of 65.3. Such an incidence and such a fatality in a sanitary town almost force us to the conclusion that vaccination itself unusually thorough and frequent, was responsible for evoking and prolonging the outbreak."

Chief Surgeon Lippincott reports from the Philippines as follows:

"I can say that no army was ever so thoroughly vaccinated as ours. Vaccination and revaccination went on as systematically as the drills of a well-regulated post, yet four thousand of these same soldiers had smallpox, from which 200 of them died. For the two years ending June 30, 1900, 13,811 were on the sick list as the result of vaccination, many of whom died and many more were permanently disabled."

In Japan, from 1886 to 1905, the total vaccinations performed numbered 91,351,407 in an average population of 43,027,661. With all this vaccination between 1889 and 1908, Japan had 171,500 cases of smallpox with a total of 48,000 deaths, a mortality of 28 per cent. If vaccination could prevent smallpox, it certainly had a chance to prove its efficacy in these two countries.

In this connection it should be mentioned that while much sanitary engineering has been done in Manila since the American occupation, diseases due to faulty nutrition among the natives are on the increase.

Instead of drawing a lesson from these experiences, a few years later the same practices were repeated during the World War. Several millions of soldiers were vaccinated against smallpox and typhoid fever with the result that, while about fifty thousand died from the effects of bullets or poisonous gas, over two hundred thousand died in homes or hospitals from so-called infectious diseases, or rather medical malpractice.

American milling processes, the production of peeled and polished rice; the importation of white flour, canned goods, etc., are largely responsible for the high percentage of infant mortality and the prevalence of beriberi and other so-called tropical diseases, caused by a deficiency of organic salts in food. The frequent appearance of smallpox goes hand in hand with the diseased condition of the blood and lymph, and vaccination always aggravates this condition and still further lowers the vital resistance of the body.

While in modern cities smallpox has decreased, a glance at the deplorable state of our children's health, as revealed by careful examinations all over the country, suffices to convince us that it has been replaced by other diseases. Smallpox is easily cured, if natural methods are employed, but the injurious effects of vaccine and serum inoculations and of unnecessary operations can seldom be remedied.

Vaccination has nothing whatever to do with the disappearance of smallpox. If this disease is less frequent in modern communities, it is entirely due to improved sanitary conditions and better care of the human body in general, but it will always occur

where people eat devitalized food and live under unsanitary conditions, despite vaccinations and revaccinations.

Here are some of the extracts on the subject of contagion from the late Prof. O. Rosenbach's book, "Physician versus Bacteriologist":

"If the opportunity for infection were even approximately as great as the adherents of modern bacteriology depict it, no nurse or physician would expose themselves to danger. But, as a matter of fact, we observe that infection of those who are engaged in nursing the sick, and of those connected with them, although they usually do not and cannot act with great precaution in their intercourse with the patients, occurs by no means more frequently than is the case with people who have nothing to do with infectious patients, a fact which certainly furnishes proof that there is a wide gulf between the possibility and the probability of infection. . . .

"If a shower of rain pours down and many persons are drenched, may it then be said that one has been infected by the other with moisture?

"The microörganisms cannot harm us so long as our organism functions normally; they are harmless if the defensive measures of our body are in good condition. . . .

"An unbiased investigation teaches more and more that what was believed could be considered the cause of disease is in many cases merely an unessential accompanying symptom. . . .

"To attempt to fight against an epidemic disease by quarantine is about as foolish as to attempt to keep away evil spirits by affixing a horseshoe over the door, or by beating tom-toms. . . . Cleanliness, external and internal cleanliness, is the only remedy for disease."

The ancient astronomers undertook to solve the problems of their science with the theory that the sun revolves around the earth once in every twenty-four hours. Those of a wider vision who at that time tried to proclaim the truth were ridiculed, imprisoned and burned at the stake. The old astronomers had the evidence of their own senses in favor of their theory! Could they not see with their own eyes that the sun rose in the east and set in the west? And could they not feel that the earth in relation to the sun stood still?

Their logic was good, but their premise was wrong. They had taken their ingrained errors for established principles; they had taken an optical illusion for a working principle of natural law.

A similar process of erroneous reasoning applies to the practice of orthodox medical science, especially to the drug and serum treatment of disease. The cause of this error is a false theory of disease itself. Different species of bacteria have been discovered, and medical science claims that these tiny organisms, invisible to the naked eye, are the direct cause of various diseases, whereas their presence does not prove, by any means, that they create disease, but rather that they are there as a result of a morbid condition of the body. Similarly does carrion attract vultures and flies. These micro-organisms instead of being responsible for specific diseases, are in most instances agents for neutralizing and removing foreign matters in the body that might otherwise prove harmful. Healthy and normal cells are absolutely impervious to bacteria. The healthy body, as a result of rational care and nutrition, has wonderful power of resistance.

Disease is a process of purification of the system—an effort of nature to burn up and cast out quantities of waste matter and poisons that have their origin in our perverted dietetic and unhygienic habits. Nature does not provide any specific remedy for disease. She inflicts penalties for every transgression of her laws. When abnormal conditions arise in one's system, the fundamental cause must be found and removed, which as a rule is the accumulation of waste poisons, or toxemia.

Nature, who develops an invisible cell into an organism of the highest perfection, knows how to restore normal conditions, if she is not hampered in her wise, but too often misunderstood methods. She does not accept vicarious atonement in the shape of pills, powders, serums or vaccines, although the medical profession is as alert as ever to prove by statistics and other means, that it can change the natural biological processes.

Suppression of disease is not cure, and nature cannot be forced into submission by medical dicta. Despite man's petty interference, she will continue building her great works even when the feeble creations of mind and hand shall have sunk into the sea of oblivion. The only way, therefore, that we can protect ourselves against disease is by living in harmony with nature's immutable laws.

At a recent meeting of the Commonwealth Club in California the problem of quarantine and vaccination of children against

diphtheria was discussed. One of the attending physicians sarcastically remarked:

"Of course, it is very comforting for a person who does not believe in vaccination to live in a community that is vaccinated, because, by virtue of the sacrifice, if it be such, that other people have taken, one can be immune to smallpox. If everybody else but himself is vaccinated, he does not then run the danger of infection by smallpox."

In the further course of discussion, Mr. C. C. Boynton, of Berkeley, a well known resident of that city, having a family of eight most beautiful and healthy children, who were never vaccinated and were brought up entirely on natural, mostly uncooked foods, made the following remarks:

"I have been informed by reliable medical authorities that in any group of normal people twenty-five per cent at any time are carriers of the diphtheria germ. Twenty-five per cent of you here are carriers of diphtheria germs; fifty per cent are carriers of pneumonia. If you are going to isolate the carriers, what is the outcome of it? The ordinary medical man is absolutely illogical.

"Now, I have known but one man who was absolutely logical on this physical theory of contagion. This was Professor Loeb, formerly of the University of California; and now by reason of his great and remarkable works, he is in the Carnegie or Rockefeller Institute. He placed physical contagion on an absolutely logical plane, and with what success? He recognized the presence of disease germs, and the result was that he realized that they were everywhere, and he would not permit you to go into his house, without first sterilizing your feet. He had no curtains on the walls by reason of the fact that germs could there assemble. Every room had its sterilization plant to destroy these germs. Yet, his next door neighbor, a distinguished professor of the University of California, told me that if a child's disease came within forty miles of Berkeley the four children of Professor Loeb invariably got it."

There is something radically wrong with an educational system that fails to keep the growing generation in sound health. To be sure, many are born with low vitality and lessened powers of resistance, due to the ignorance of their parents, but even a weak body can be restored gradually to normal condition, if careful attention is paid to rational nutrition and all the other factors necessary to the attainment of health and strength.

In the present enervating struggle for existence man should

first of all be taught how to take proper care of himself, how to develop mind and body in order that he may live a full and happy life—useful to himself and others. The study and teaching of rational nutrition should constitute an important part of every common school curriculum, as we can hardly expect that people, who know nothing about their bodily functions and the fundamental laws of health governing them, will be able to maintain physical vigor in themselves and their offspring.

Disease is never inherited, although faulty organization or predisposition to functional disease may be. If diseases appear in children, they are due to the same causes that produced them in the parents.

In a study he has made of rural health and national well being, Dr. Irving Fisher, of Yale University, finds that only about one per cent of the people are well and free from impairment. He says:

"What would we think if 99 per cent of a dairy herd, or of a flock of sheep were found impaired? It means that we are losing a large per cent of our rightful life, not only by death itself, which cuts off many years we might have lived, but also from disease and disabilities which are not fatal, but which cripple the power to work and mar the joy of living. We may assume that on the average for every death per annum there are two persons sick during the year. This makes about 3,000,000 people constantly lying on sick beds in the United States, of which on the most conservative estimate, at least half need not have been there. If we translate these preventable losses into commercial terms, we find that even by the most conservative reckoning, this country is losing over $1,500,000,000 worth of wealth producing power every year."

But the economic waste does not stop here. We have to employ an army of physicians and nurses to look after these invalids; we have to maintain hospitals and asylums,—in short, a like amount is spent in trying to restore the health of those who are suffering as a consequence of their ignorance and helplessness. We may safely say that the American public spends annually over three billion dollars for doctors' fees, drugs, and proprietary medicines, besides losing much valuable time and lowering vitality and power of resistance.

The majority of people do not know what real health and efficiency mean; their vitality is constantly below par on account of

the neglect of personal hygiene. Indispositions are regarded as a matter of course, caused by the weather, or other external conditions. People have not as yet learned to look for the cause of disease within themselves.

Bacteriology has led the medical profession in the wrong direction, and it will take some time before its mistakes are generally recognized and publicly admitted. Commercialism and political influence are now so interwoven with the teaching and practice of medicine that it will need the combined efforts of all progressive thinkers to change the trend of thought of suffering humanity regarding the real cause of disease—enervation and lowered vitality due to wrong living.

CHAPTER XIII

Medical Science and the Cure of Disease

Medical science has failed to solve the problem of health and disease through the employment of *materia medica* and surgical operations, because it has not yet mastered the great underlying principles governing the phenomena of life. It has not awakened to the fact that the body is an organic whole; that in the last analysis diseases have one common source—diminished vital force or enervation, resulting from the retention of waste poison; that pain is but a logical symptom of general disorder; and that, finally, if any real and permanent benefit is to be achieved, successful treatment cannot consist in confining one's efforts exclusively to the organ or part affected, but the organism must be treated in its entirety.

Cures, like fashions, have come and gone. Such dubious remedies as anti-toxins, tuberculin, turtle's blood, salvarsan, and a hundred others have been heralded to a suffering world as wonderful discoveries of medical science, only to be abandoned after a brief period as unsatisfactory.

The tremendous growth of the drug industry in the United States is positive proof of the inability of the medical profession to treat their patients in a rational and efficient manner. During the last thirty years over forty thousand new remedies have been put on the market, and their number is constantly increasing. A statement by the Department of Commerce shows that more than four hundred million dollars' worth of drug products were manufactured in the United States alone during 1921. A world wide demand for laboratory examinations and surgical operations has been created, and the modern doctor's treatment rooms, equipped with imposing apparatuses, are designed to convince the patient of the progress of the medical profession. Here he is confronted with X-ray machines, microscopes and other complicated paraphernalia, whose primary aim is to instill the belief that everything worth knowing is beyond the ken of common minds; and that only those who have diplomas from leading universities and a row of

titles affixed to their names have the key to the problems of life. This atmosphere of mystery and awe has a most depressing effect upon the mind of the patient, and tends to rob him of the last vestige of confidence in nature's healing forces. The mania for looking everywhere for the cause of his ailment, except in his own perverted dietetic and hygienic habits, is hereby confirmed, and he gradually becomes resigned to a life of chronic ailment.

The honest and capable physician is compelled to contend with ignorant and superficially educated men and women who are searching for palliatives and not for permanent cures, which require perseverance and self-control. "Every disease," said Dr. E. H. Dewey, of fasting fame, "is an inherited possibility, which every violation of the laws of life tends to develop. It is never simply an attack on a well person, but rather a summing up of the more or less life-long violation of health laws."

The majority of people have yet to learn that lasting health can only come through a true understanding of the normal functions of the body, and an application of simple and rational methods for maintaining them in a healthy condition. Because a few who have inherited a large amount of vitality are able with apparent impunity to defy the laws of nature for some time, many are disposed to sneer at rational methods of living. As a rule, however, disease claims them as her own when they have attained middle age, when man's powers should be at the height of efficiency.

Vivisection is one of the fallacies of medical science, developed through its endeavor to look for new methods of curing disease by serum therapy. The newly discovered remedies are urged as reasons for cruel experiments on animals. Even though, for the sake of argument, it were admitted that germs cause disease, it is a fact that no animal has ever suffered from precisely the same disease as a human being. Human diseases cannot be inoculated into them. As a rule only the concomitants of blood poisoning are produced. For this reason medical science itself will never be able to form any definite conclusions concerning the reliability of the results of vivisection. In fact, many far seeing physicians whose minds have not been biased by bacteriological fallacies, have never looked to vivisection as a necessary adjunct to the cure of disease.

Dr. Walter R. Hadwen, one of England's leading physicians,

in a public lecture given at Los Angeles, California, June 16, 1921, remarked:

"In my own country during the fifteen years after antitoxin was introduced, the death rate from diphtheria rose 25 per cent above the death rate fifteen years before, and bacteriologists can only attempt to show a reduction in fatality by a scandalous system of statistical jugglery, whereby large numbers of common sore throats are thrown into the count and called diphtheria on the basis of the fallacious germ theory of disease. Diphtheria serum has killed without a doubt thousands of children directly, though it has never had the slightest effect in preventing or curing diphtheria itself, and I challenge anybody to prove that it has ever saved one single life. It is based on superstition; it is built upon unscientific theories; it is manufactured at the expense and torture of animal life, and is the greatest disgrace of the medical profession that the world has witnessed in the course of the centuries."

It is really surprising to hear physicians who should know better say that the use of living animals for experiments is necessary for the conquest of some diseases, and for the intelligent treatment of others. John D. Rockefeller, whose little grandson died as a result of cerebro spinal meningitis, was so moved with a desire to promote experimentation along these lines that he founded the Rockefeller Institute for Medical Research in which vivisection is a prominent feature. With the proper knowledge, he could have devoted his millions to far better advantage by giving the people some really fundamental knowledge about the cause and cure of disease.

Dr. S. Flexner, the leading spirit of the Rockefeller Institute, in telling about his discovery of serum for the alleged cure of meningitis, said some fifteen years ago:

"Once we have tried our remedies with satisfactory results upon animals, there is very little risk to human beings; and of course in treating the latter we shall proceed with the utmost caution.

"Take my own serum for meningitis, for instance, without monkeys we never could have discovered that. First, we had to prove that the monkey really had meningitis, and then we could go ahead with experiments for its cure. We injected the serum into its spine, and found it did good—at any rate it did no harm.

So we could inject it into the spine of a human being with confidence that we were not doing him any harm.''

It appears that Dr. Flexner's statements are very much qualified and that his experiments breathe the spirit of uncertainty. To the analytical mind it seems unreasonable to make animals in the abnormal state of pain the basis for medical research. In Dr. Flexner's experiments, the *symptoms* of the disease had been produced artificially in the monkeys by sub-cutaneous injections, while in the human system the disease is caused by faulty nutrition.

Spinal meningitis will continue its ravages so long as there are mothers so misinformed as to make no effort by hygienic living to properly nurse their children. Artificial feeding of infants is at the root of many children's diseases and must be regarded as one of the stupendous errors of civilization.

It is deplorable that even those who are at the head of our leading educational institutions have not acquired a deeper understanding of the cause of disease. Dr. Ray Lyman Wilbur, President of Stanford University, in a recent attack against anti-vivisectionists, said:

''Where do they think medical scientists learned to keep typhus and typhoid and tuberculosis out of this country, except through experimentation on animals?''

''We are able to progress only by such experimentation; we have gained all our knowledge by means of it. Even in the dark ages people learned to give way to medical science; yet those who oppose vivisection, done under anaesthetics and humane in every way, would take from doctors their only source of certain knowledge.''

Vivisection is built on a false hypothesis, and nothing worth while and of lasting benefit can be achieved by it. Vivisection is not merely a question of cruelty to animals, but it involves injury to human beings as well. There is no doubt that serums and vaccines, administered as a result of animal experimentations, have done a great deal of harm, even caused many premature deaths as a result of blood poisoning. Man is so selfish that he permits thousands of animals to be needlessly tortured, if he is told that he may thereby prolong his own life a short time.

If medical colleges and universities would devote more time to a study of the chemistry of food and nutrition, especially to the

organic salts in their relation to health and disease, and less time to bacteriology and animal torture they would find a tangible basis upon which to proceed intelligently in the treatment of disease, and thereby perform a real service to mankind.

Contrast the allegations of Dr. Wilbur with the following statements of Sir Charles Bell, a very eminent Scotch surgeon, taken from his book "The Nervous System of the Human Body":

"Experiments on animals have never been the means of discovery, and a survey of what has been attempted of late years in physiology will prove that the opening of living animals has done more to perpetrate error than to confirm the just views taken from the study of anatomy and natural motions.

"In a foreign review of my former papers the results of my investigations have been considered as a further proof in favor of vivisection. They are, on the contrary, deductions from anatomy, and I have had recourse to experiments, not to form my own opinions, but to impress them upon others. It must be my apology that my utmost efforts of persuasion were lost while I urged my statements on the ground of anatomy alone."

Here we have conclusive proof that Sir Charles Bell's famous discovery of the double action of the spinal nerves was a scientific deduction from anatomical investigation and had nothing whatever to do with experiments on animals.

Many medical men, indeed, have confessed that vivisection, far from benefiting science, is both detrimental and misleading. To illustrate, during ten years, Dr. Schiff, a noted surgeon, vivisected 14,000 dogs. It is estimated that he vivisected during the same period 70,000 animals of various kinds; and for some time he had been regularly torturing ten dogs each week. To prove one hypothesis, over 9,000 dogs were vivisected, and the result was then in doubt.

Serum therapy which has been mentioned as being responsible for the torture of thousands of animals, is now a subject of controversy even among members of the medical profession.

Dr. Tilden in "Philosophy of Health" quotes from an allopathic physician who is frank and intelligent enough to admit the failure of serum therapy:

" 'The treatment of diseases, or their prevention, by antitoxins, serums, and vaccines is still very largely in the experimental stage, with grave doubts as to the value of the vast majority. Unfortunately much of our literature on these subjects, including statistics, is furnished by the manufacturers who are interested,

above all things, in the financial aspects of their production. One of the most prominent general practitioners in Ohio called my attention some months ago to the fact that even diphtheria antitoxin acquired its reputation when the doses used were so small as would now be regarded as entirely inadequate, and those doses given at a stage of the disease in which their administration is now looked upon as practically useless.

" 'A number of years ago there was a grave epidemic of diphtheria in Philadelphia. The epidemic was proving disastrously fatal when a firm of manufacturing pharmacists appeared and, with the claim that the antitoxin had not been properly administered, proposed to the officials that they would take charge of the situation, would furnish antitoxin free of expense, and would supervise its administration, provided merely that they should be permitted to use the statistics which they would thus obtain. Their proposition was promptly accepted; the antitoxin was used with a free hand; *but the statistics were never published!* I refer to this merely as an illustration of the purely commercial attitude of the manufacturing firms. Statistics can be of no possible value when unfavorable ones are suppressed and only the favorable ones published. It is an old legal aphorism, *Falsus in uno, falsus in omnibus*—false in one thing, false in all—and that maxim should be rigidly applied to all such reports, statistical and otherwise.

" 'The treatment of pneumonia may be looked upon, as suggested by Osler, as a sort of test of the serum type of therapy. It is a disease that is always with us, has a frightful mortality, and its lesson is always a lesson of humility. It is doubtful if the death-rate today is any less than it was a thousand years ago. We had hoped much from the "typing" of this disease which attracted so much attention a few years ago; but my medical friends assure me that the resulting treatment has been a distinct disappointment, if not a complete failure. As Osler suggests, we must accept the truth, however unpleasant, and, with this death-rate before us, not be deceived with vain fancies.' "

Serum therapy ignores the ever-active vital force in all animated beings. No physician could ever explain the assumed remedial action of antitoxin by the laws of physiological chemistry and biology. The fewer fatalities since the introduction of antitoxin are explained by the fact that eighty-five per cent recover despite the serum treatment. Before the days of antitoxin the great mortality in diphtheria cases was largely confined to the regular school. Homeopaths, eclectics and the drugless healers were more successful, as any physician would be who does not interfere with nature's eliminative processes.

There has been a general lowering of the severity of the type

of diphtheria and a decided fall in the death rate during the last thirty years, but this cannot by any means be attributed to the introduction of antitoxin. Antitoxin simply did less injury than former drastic treatment with poisonous drugs Yet despite this malpractice, twenty-five per cent of the afflicted children survived, while following antitoxin treatment eighty to ninety per cent lived through the disease. Antitoxin really killed fewer than the old time treatment and the difference in the mortality seemed miraculous to the profession, so much so, indeed, that they felt themselves entitled to enforce their doctrines of serum therapy by law.

Very likely those practicing the old treatment were satisfied that by hard work and skill they had saved twenty-five per cent. The thought never entered into their mind that the treatment itself had been fatal to from sixty to sixty-five per cent of the total number who died. Antitoxin being less destructive in its effects gave a chance to *vis medicatrix naturae* (nature's healing power) to assert itself.

It is against all the laws of logic to assume that a dead or inert substance taken from a diseased animal should in some mysterious way impart vital force to a feverish body. Antitoxins and serums always gravely impair the vitality of the system, which has to eliminate these virulent poisons.

A rational system of healing must be constructed upon the eternal foundations of truth, and upon the firm belief in nature's restorative power. Only such forces should be employed as really replenish the waning vitality of the body: sunlight, air, water, mechanical treatment, exercise, rest, a hopeful attitude of mind and, last but not least, a carefully selected diet.

Rational diet is one of the greatest factors in Nature Cure, as it tends to establish self-control and confidence in the healing power of nature. All the branches of Nature Cure, hydrotherapy, physical culture, osteopathy, chiropractic and suggestion are important, but in order to be of lasting value they must be combined with the proper feeding of the patient.

Unfortunately, there is hardly a subject of which the average physician knows less than that of rational nutrition, because the medical colleges do not devote sufficient time to the study of this most important factor in the successful treatment of disease. The

average physician is still blinded by his belief in drug and serum treatment.

While food is a great factor in the restoration of health, it can be of value only in so far as it is properly digested and assimilated. In other words, in prescribing a diet it is necessary to consider the condition and vitality of the patient. Even the best food cannot make a dead man live, inasmuch as only the living body can act upon food elements and change them into blood, on which life depends. Foods must become an intrinsic part of the body before they can be acted upon by its inherent vital force, and utilized in the production of heat and energy or tissue building. Therefore, since serums and vaccines can never become an integral part of the blood, their uselessness becomes evident. They are acted upon by the vital force and thrown out of the system as quickly as possible. The body's reaction is often mistaken for an improvement, and increased doses are prescribed until vitality is exhausted and the patient dies.

The human body has been likened to a steam engine in which the foods are burned up like so much coal or oil, giving out a certain amount of calories or heat units. This is a mistaken idea; food is not directly used as is the fuel of an engine, but it must be digested and assimilated before it can be oxidized in the body and transformed into muscular and mental energy. If the general health is impaired, the power of the digestive organs is proportionately lowered, and a temporary rest is needed. This can be best accomplished by a short fast. It is the height of folly to feed a patient during a case of fever, as the food will be actually turned into poison. To give a sick person plenty of so-called "good, nourishing food" is to overtax his weakened digestive organs and still further lower his vitality, often with fatal results.

We must learn to judge the medicinal or remedial value of foods chiefly by their contents of alkaline organic salts, which are nature's true antitoxins, when they have become a part of our body. Fresh fruit juices sipped slowly and in moderate quantities should be the only foods permissible in acute diseases.

Lasting health and the preservation of vital force can be achieved only by self control and rational living. In eradicating disease it is not necessary to fight germs or microbes, but rather man's ignorance, his violation of natural laws, lack of self con

trol and his overindulgence—in short, his ingrained thoughts and habits.

It is not within the scope of this book to enter into lengthy details concerning the cause and cure of all acute and chronic diseases. Only a general outline can be given. Much has to be left to the skilled and experienced nature cure physician, who, fortunately, is now becoming more and more conspicuous in this country, notwithstanding the untiring efforts of representatives of the old schools of medicine to impede his progress and narrow his field of activity.

Enlarged Tonsils and Adenoids are among the most frequently occurring diseases of childhood, and medical science still relies upon the knife of the surgeon as the only cure. The functions of the adenoids and of the tonsils are closely related to each other, as they neutralize poisons that are generated in the mouth and upper respiratory tract, and assist in the functioning of the other lymphatic glands. The diseased condition of the glands is a result of an undue accumulation of waste poison in the system, due to faulty diet. If we consider the fact that the majority of children indulge in an excess of artificial sweets and starchy foods, deprived of the important organic salts and vitamins, we shall find a rational explanation for these deplorable conditions. The deficiency of iron, sodium and calcium in the blood leads to an accumulation of carbonic acid and other waste poisons, overtaxing all the lymphatic glands. Removal of the glands, while lending at best only temporary relief, does not strike at the root of the evil which is irrational living. There is positively no need for such operations, since natural foods, sleeping near open windows, and the taking of sun baths, whenever convenient, will readily alleviate all functional disorders, provided the vitality of the patient is still strong enough to react properly.

Comparatively few parents understand how to feed and clothe their children, and depend too much upon the advice of orthodox physicians or surgeons. However, almost any apparently healthy child, surrounded by artificial conditions of city life, is apt to develop occasional disorders during the first ten years of its life, but these reactions are due, as a rule, to nature's efforts to eliminate surplus waste matter, and are beneficial and necessary. Intelligent physicians never attempt to suppress these symptoms by medicines

and operations, since such methods lower the vitality of the child and lay the foundation for chronic diseases in after years. A diet consisting exclusively of fruits or fresh fruit juices for a few days, or longer, will alleviate the diseased condition and gradually restore the normal functions of the body. In fact, fresh fruit should always constitute a substantial part of the growing child's dietary, as in this way it will be protected against acquiring the craving for artificial sweets.

Constipation, for the relief of which humanity is swamped with remedies, would appear to be an almost universal ailment, and is largely the result of the increasing consumption of devitalized and demineralized foods. Shrewd advertising has made some of these products almost household words, and the public has acquired faith in their value.

There is nothing more conducive to constipation than the continuous use of white flour products, concentrated sweets, meat, spices and condiments, since they increase the acidity of the blood and weaken the chemical action of the mucous membranes of the intestinal canal. Any drastic remedy will only serve to enervate and leave the digestive organs in a still more weakened condition than before. The gradual adoption of a diet consisting largely of natural, uncooked foods, thoroughly masticated, combined with plenty of outdoor exercise will bring permanent relief. We should remember that constipation is an indication of a general lowered vitality of the body and that we must bring all the natural remedial factors into play in order to insure normal and healthy action of the bowels, without having to take recourse to artificial means.

Cancer is a disease that is on the increase in all civilized countries, baffling the skill of the medical profession, though we should bear in mind that the various forms of malignant growths are as a rule included under the general name of cancer. Naturally, it is assumed by the medical profession that a specific germ is responsible for this malady, and hundreds of medicines, in addition to repeated surgical operations, have been offered as cures.

The proportion of cancer cases in a community appears to be in direct ratio to its consumption of meat, alcohol, tobacco, spices and condiments in general. There is no doubt that the cause of all

malignant growths of the body is the highly toxic condition of the blood induced by years of irrational living. Not all abnormal enlargements of the tissues are of a cancerous character, and in the majority of cases a strictly regulated simple diet will prevent serious consequences. But again, people as a rule are so frightened by the appearance of even a slight protuberance on the body that they aggravate the condition, and are easily influenced to submit to an operation.

Besides the germ fallacy, many other theories have been advanced as the cause of this disease. Even tomatoes and potatoes have been made responsible for it. The only rational explanation is to be found in a highly acid-forming diet, which, during the course of years, leads to degeneration of blood and tissues. Foods especially rich in nitrogen and phosphoric acid will always promote abnormal growths in parts of the body that are subject to frequent exterior stimulation, since the lack of alkaline elements in the blood prevents the removal of waste matter through the excretory organs. Common sense should tell us that surgical operations for cancer, or any other disease, can never remove the cause since the blood will remain in the same depleted condition. On the other hand, relief, if not cure, can be effected in most cases without an operation, through a radical change in diet.

These facts are beginning to be recognized even by those physicians who have become world-famous for their skill in performing surgical operations. Speaking before the Rhode Island Medical Society, Dr. William J. Mayo said:

"Cancer of the stomach forms nearly a third of all cancers of the human body. So far as I know this is not true of the lower animals, nor uncivilized man. Is it not possible, therefore, that there is something in the habits of civilized man, in the cooking or other preparation of his food, which acts to produce the pre-cancerous condition? Within the last hundred years, four times as much meat has been taken as before that time. If flesh foods are not broken up, decomposition results and active poisons are thrown into an organ not intended for their reception, which has not had time to adapt itself to the new function. When cancer in the human race is frequent, a close study of the habits of civilized man, as contrasted with primitive races and lower animals, where similar lesions are conspicuously rare, may be of value; and finally, the prophylaxis (prevention) of cancer depends first on a change in those cancer producing habits, and second, on early removal of all precarious lesions and sources of chronic irritation."

We must, however, take exception to the second suggestion relating to surgical operations. A diet that supplies sufficient alkaline elements, and at the same time diminishes the amount of protein, will gradually reduce the acidity of the blood so that it can assist in removing lesions by re-absorption, thereby obviating the necessity for operations.

This view is confirmed by the late Dr. Willard Parker, a well known New York surgeon, who said:

"Cancer is, to a great extent, one of the final results of a long continued course of error in diet; and a strict dietetic regimen is therefore the chief factor in the treatment, prevention and cure. . . . . . In regard to the effect of abstemiousness in cancer, I speak with great positiveness that vegetables, or at least a very bland diet, does check the progress of the disease, and in some cases now under treatment has been attended by an alleviation of symptoms, and in a few instances by a recession of growth."

The races that consume the smallest amount of meat, or are practically vegetarians, are remarkably free from cancer. Dr. Madden, of Cairo, says that cancer is never found among the black races of Egypt who are Mohammedans and vegetarians. In Lagos, during fourteen years, Dr. Johnson saw only five cases of cancer among the natives, and in all of these five cases the afflicted were meat-eaters. Brazil, with its abundance of fruits, has the lowest death rate of any part of the western world, while in the Argentine Republic, where the consumption of meat is the highest of all countries, cancer is a very common disease.

In England where cancer is alarmingly on the increase, the people consume over 130 pounds of meat to each person every year, which is more than double what it was fifty years ago. At the same time the cancer mortality has increased more than four times, surpassing in this respect all other diseases. In other countries the same thing has occurred, but wherever the consumption of toxic drinks and of meat and tobacco has been small, the cancer rate has kept comparatively low.

Alcoholic beverages also seem to bear a causal relation to cancer. The beer and wine drinking countries, like France, Australia and Germany, have a higher cancer mortality than most Oriental countries; Munich, Stuttgart, Copenhagen, and Salzburg having about the highest rate in the world. Beer is well known to produce gouty and rheumatic poisons in the system.

The exemption of tribes of negroes and of other natives has been described by medical observers. In the most recent report of the *Cancer Research Fund* the general absence of cancer among Papuan, Malaysian and Australian natives is confirmed. But they do become afflicted when living like Europeans and adopting a stimulating diet of highly seasoned dishes in place of their simple and natural foods.

The common occurrence of cancer among the backwoodsmen of North America and Norway is surprising considering their strenuous outdoor life. But it seems that their fare in North America consists of very large quantities of pork, bacon, molasses, etc., and of strong tea; while the Norwegians consume large amounts of coffee. Such drinks are destructive to the nervous system and the foods are highly acid-forming.

Cancer of the stomach and liver is common among both men and women, and it is due to local irritation produced by perverted dietetic habits. Pepper, mustard, and pickles, when eaten freely, act as local irritants. The free use of sugar, jellies, fried foods, pastry and confectionery favors fermentation and the formation of acids which also irritate the mucous membrane.

In the study of the etiology of cancer we must never lose sight of the fact that the integrity of each individual cell is dependent upon a pure blood supply, which contains the organic salts suitable to its physiological necessities. To retain the cellular tissue in a healthy and vigorous condition, it is essential that it is provided with foods which are rich in the alkaline elements. A diet devoid of the vital principles of fruits and vegetables will always favor the formation of cancerous growths. It is absurd to attribute the disease to cancer parasites.

The inability of the regular medical profession to cope with cancer is illustrated by the fact that a few years ago Dr. William T. Bull, a noted New York cancer-specialist, died of cancer himself. Says the newspaper report:

"Cancer was one of the diseases in the treatment of which he had been an eminent specialist, and he studied his own symptoms and directed what should be done. A surgical operation was performed according to his directions and serums then used.

"It is a curious coincidence that the disease which he knew the best was the one which struck him down. When the dread scourge first made its appearance, he was having a bust of himself made

and knowing that he was doomed, he continued the sittings as often as possible so that the work might be finished before the disease made it impossible. His death has been daily expected for some time and it was only through the use of great will power that he lived during the last three months."

Like so many of his colleagues, Dr. Bull had an entirely wrong conception of the disease which ended his life. How can a vitiated blood stream be improved by surgical operations and serums? A complete reform in the dietetic habits of the patient is one of the first essentials for the cure of cancer, if it has not already progressed too far.

So alarming has been the increase of cancer cases in the United States since 1905, that the government has established a "cancer week," during which efforts will be made "to spread the facts regarding cancer, its causes, treatment and prevention." It is certain that information based upon a wrong conception of disease cannot prove helpful.

Nature's universal cancer prevention is to be found in a simple, non-stimulating diet, consisting mostly of fresh fruits and green leaf vegetables, with a small amount of protein foods, avoiding all flesh foods, salt, sugar, condiments, alcoholic beverages and tobacco. Frequent sun and air baths are likewise great healing factors in the cure of cancer. We cannot, however, expect that a disease which is the result of a lifetime of wrong living will disappear in a few weeks or months. But by self control, patience and perseverance complete recovery will ultimately result, that is, if the vital forces have not been vitiated by conventional treatment and the disease advanced too far.

Dr. Frances Carter Wood, Director of the Columbia University Institute of Cancer Research, gives the following statistics:

"Between the ages of 15 and 19 only one person in 250,000 dies of cancer. Between 20 and 24 only one person in 200,000. Between 25 and 34 one man in 10,000 and one woman in 5,000 dies of cancer. And so the rate rises until between the ages of 65 and 75, one man in 200 and one woman in 150 dies of cancer."

These figures clearly show that the deaths from cancer increase with advancing age, as the accumulative effects of faulty nutrition.

Surgical operations can give at best only temporary relief, while they ultimately retard nature's healing process, and are often followed by fatal results. In the treatment of no other disease

does the average physician show less understanding of the laws of life and health than in the treatment of cancer.

Diabetes is a diseased state of the functions of nutrition, characterized by an abnormal urinary excretion of sugar, amounting to from one-half ounce to three ounces per day, and in serious cases to even more. This condition is the result of a highly increased acidity of the blood, which is deficient in iron, sodium, lime, and sulphur, the elements necessary for the formation of red blood corpuscles. Overeating and the habitual use of alcoholic beverages, even in moderate amounts, are the principal causes of this disease. Although some of the diabetic patients may look well fed, they are anemic and lack endurance. On account of lack of sodium, the blood is surcharged with carbonic acid, and at the same time the deficiency of iron, lime and sulphur prevents the intake of a sufficient amount of oxygen into the lungs, so that an incomplete combustion of the carbohydrates results. The proscription of sweet and starchy foods may reduce the amount of sugar in the urine, but will by no means constitute a permanent cure. Only by bringing the blood back to its normal alkalinity will the natural combustion of the carbohydrates be assured. It is not necessary to avoid the natural foods that contain starch or sugar as long as a sufficient amount of alkaline elements is provided. The so-called gluten bread, often recommended to sufferers from diabetes, is worse than useless, as gluten flour is deficient in the essential organic salts that are washed out in the manufacturing process. Furthermore, a surplus of protein, such as is apt to result from a gluten or meat diet is split into carbohydrates and uric acid. Diabetes is frequently associated with anemic, scrofulous and gouty conditions, which are all due to the same causes, and, therefore, can be prevented only by the adoption of a diet which supplies alkaline elements necessary for the formation of normal blood. Naturally the process of readjustment will be slow, as it often requires several months or more of careful dieting to eliminate the poisons which have accumulated during years of wrong living, and to restore the healthy functioning of the digestive organs.

The occurrence of diabetes varies greatly with location and race. On the island of Malta the diabetes mortality is 37.8 per 100,000, in Bordeaux, 25.8; Berlin, 20; Paris, 17.6; in the United States the mortality in Worcester is 27.3; Syracuse, 25.7; Boston, 17.9; New

York, 17.4. The disease is common in some parts of India, especially in the large centers of population under European influence. Few cases of diabetes occur among the poor Chinese, though the rich suffer more. That the colored race suffers less than the whites is shown by the fact that the mortality among negroes is 8 per 100,000 and among the whites 16.3.

In western Europe and America the disease is increasing. For instance, in England and Wales the mortality in 1886 was 5.9; in 1907, 19.7. In Paris in 1881 the mortality from diabetes was 5.8; in 1890, 13; and in 1905, 17.6. An increasing mortality from this disease has also been noted in Copenhagen, Berlin, and Australia. In America the mortality has doubled in twelve years. Diabetes will continue to increase as long as people persist in excessive consumption of meat, white flour products, artificial sweets and alcoholic beverages.

Gout and *rheumatism* are the result of a continuous over-indulgence in concentrated foods, containing an excess of protein and phosphoric acid. The system becomes unable to eliminate the urates and phosphates, which settle in the joints in the form of small crystals and cause painful inflammations. The regular use of alcoholic beverages, coffee and tea are often contributory causes, as they interfere with the elimination of waste poisons. When larger quantities of these uric acid crystals accumulate, they will form little lumps that gradually become hard and appear as gall, bladder or kidney stones, causing frequent pains in these organs. A diet rich in alkaline elements, especially sodium, will gradually dissolve and excrete these poisons. Meat, cheese, legumes, spices and condiments should be avoided, while nuts and cereals, except whole rice, should be used sparingly. One meal each day should consist of a combination salad, another one of fresh fruit. Relief will often come slowly and pain will often reappear until all the toxins are eliminated. Frequent sun and air baths are also beneficial in improving the action of the skin. In the treatment of chronic rheumatism it must always be remembered that a considerable amount of toxins is stored up in the tissues. As soon as the eliminative treatment begins, these toxins re-enter into the circulating blood and cause temporary pains: This is the case especially after a diet of acid and subacid fruits, which are avoided

by many on account of this very eliminative action. The fact cannot be too much emphasized that in the restoration of health the body must pass through a succession of more or less severe healing crises. Those who understand the laws of health will therefore not deviate from natural healing methods because of occasional pain which, in this instance, is but an indication of the body's gradual return to normal conditions.

Hardening of the Arteries (arteriosclerosis). "A man is as old as his arteries" because the circulation of the blood depends upon the arterial tension. The heart alone could not perform the tremendous task of constantly forcing the blood through the arteries and capillaries were it not for the arteries, which by means of their muscular walls, assist in circulating the blood. If the arterial walls gradually become encumbered with phosphates, urates and other waste matter and thereby deprive the vessels of their natural elasticity, additional work is thrown upon the heart, thus abnormally increasing the blood pressure. The additional heart pulsations make a very appreciable strain upon the vital forces, often causing hemorrhages.

In hardening of the arteries there is a gradual thickening of the arterial wall. It may become two, three, four or even more times thicker than normal. As the arteries become encumbered, they lose their power of muscular contraction and extra work is thrown upon the heart to force the same amount of blood through the narrow openings. The function of the heart becomes more and more enfeebled, the supply of blood to all the organs of the body is lessened and the signs of senility appear.

The cause of old age is not so much the presence of phosphate of lime in the food, but rather the accumulation of waste matter in the body. Under the influence of these poisons, nutrition is impaired, and the arteries, as well as other tissues, take on degenerative changes resulting in a calcareous condition.

The constant use of alcoholic beverages, tobacco, spices and condiments, coffee, tea, meat and even a too frequent consumption of cereals and legumes are the principal causes of arteriosclerosis, which can in its early stages be relieved by the adoption of a non-stimulating diet, including the daily use of fresh fruits and vegetable salads, with a small amount of protein food. Lack of

fresh air and exercise, in fact everything which retards and prevents the elimination of waste matter, will favor the hardening of the arterial vessels, often before middle age is reached.

The use of such drugs as strychnine, digitalis, etc., to stimulate the action of the heart, may bring temporary relief, but at a fearful cost to the vitality of the patient, who will require constantly increasing doses as this artificial stimulation is continued.

Diseases of the Liver. The function of the liver, which is the largest organ of the body, is to purify the blood by separating from it the waste products, such as uric acid, ammonia, taurin, etc., and to neutralize them so that they can be excreted through the kidneys. The liver promotes the pancreatic digestion and the absorption of fats by the bile which it pours into the intestines.

The liver is the chemical laboratory of the body whose perfect working order depends on the sufficient supply of organic salts, especially potassium, sodium, calcium, manganese, iron and chlorine. The liver in its normal state is a masterpiece of nature's economy. It filters the waste poisons from the blood and transforms them into bile, which is important for the proper digestion and assimilation of fats and the regular movement of the bowels. It is a storehouse for sugar and iron. The sugar is stored up in the liver cells in the form of glycogen (liver-sugar), and is given to the various tissues when they require their daily rations. When the blood-making glands need more iron for replacing worn out blood corpuscles, they have to make a requisition on the liver. And there are still several other tasks that this busy organ has to perform. We should not, therefore, be surprised if the liver goes on strike, or even occasionally indulges in sympathetic strikes when other digestive organs are seriously ailing through our dietetic mistakes.

As a sluggish and congested liver is caused by highly seasoned meats, especially pork, also pastry, artificial sweets, spices, condiments, alcoholic beverages, etc., these articles should be discarded from the dietary if relief is desired. Eggs and nuts may be used sparingly, and always in connection with green leaf vegetables. Apples, oranges, grapefruit, and tomatoes are especially recommended. A so-called "fruit fast" for a week will bring great relief.

Tuberculosis, commonly understood as a chronic disease of the lungs, is usually the outcome of other diseases, such as anemia,

chlorosis, diabetes and scrofulosis, since all have the same origin—impoverished blood. In many cases there may be predisposing causes, such as inherited low vitality. Furthermore, as children live under the same environment and partake of the same food as their parents, they are apt to develop the disease sooner or later. The increasing consumption of devitalized food, alcohol, and tobacco, sexual excesses, overwork, and worry, are the principal factors in swelling the number of tubercular patients. There are in the United States 160,000 deaths annually from tuberculosis. Nine per cent of all deaths, and every third death that occurs between the ages of sixteen and sixty are attributable to this disease. True to their perverted bacteriological doctrines, the medical profession has made an invisible germ responsible—the *bacillus tuberculosis*—discovered by Dr. Koch about forty years ago. This germ has been made the scapegoat for the dietetic omissions and commissions of man, and since its discovery, relentless war has been waged upon it. However, the attempts of orthodox medicine to stamp out the germ and its disease have proved futile. The practice often resorted to of stuffing the patient with "plenty of nourishing food" has killed more patients than the disease itself. One of the weakest organs in all sufferers from tuberculosis is the stomach, and to force into it large quantities of meat, eggs and milk, only serves to increase the acidity of the blood and fill the system with additional waste matter. The common practice of sending patients to warmer climates only serves to prolong the suffering, unless a radical change in the diet is made. Naturally, fresh air and sunshine are important factors in ultimate recovery, but too much stress cannot be laid on the adoption of a simple, natural, non-stimulating diet. The best localities for consumptive patients are places from 2,000 to 3,000 feet above sea level where the air is cool and free from dust. Drugs and serums must be strictly avoided, and the diet adapted to the vitality of the patient. Fresh fruit and fruit juices, and well prepared vegetable salads should make up the principal portion of the dietary, in order to increase the red corpuscles of the blood.

Pulmonary tuberculosis remains from economic point of view, one of the most costly diseases. Carefully prepared data show that the average cost of the 160,000 persons who die from this disease each year in the United States, including the loss of time and expense incurred during three years of sickness, is not less than

$8,000 each, making a total of $1,280,000,000, or more than a billion a year. Only a rational system of education, teaching the true conservation of vital forces can prevent this tremendous waste of life and wealth.

Climatic Fevers (malaria, yellow fever, dysentery, etc.) are all afflictions due to hot, moist air, poor in oxygen, and to dietetic mistakes. Our dependence upon atmospheric conditions appears under most varied conditions. For instance, malaria and yellow fever seldom occur 3,000 feet above sea level, since the peculiar electricity of air in motion is communicated to our bodies. We are all healthier in a dry atmosphere on a sandy soil, which holds the electricity, than we are in moist regions which carry off electricity from our bodies. It is a well known fact that moist air absorbs much more heat than dry air, while the proportion of oxygen in the former is considerably decreased.

The northerner who goes to the tropics, seldom makes a change in his diet. He takes his canned meats and alcoholic beverages along, which deprive the body of oxygen, removing at the same time, by the increased secretion of urine, the important minerals from the blood. Our immunity from the effects of unfavorable atmospheric conditions depends upon a sufficiency of red blood corpuscles, which absorb oxygen, and this necessitates the taking of foods rich in calcium, iron, sodium and magnesium. Not enough can be said against the use of quinine and other antipyretics, which may suppress the feverish symptoms for the time being, but only at the expense of future suffering. Even men of robust constitution will become nervous wrecks through the constant use of these poisonous alkaloids, which seriously interfere with the action of the spleen and liver upon which the purification of the blood and the invigorating of the nervous system depend. There is an idea extant that the eating of certain fruits in tropical climates induces fever, but in every instance the disease can be traced to other causes than the partaking of wholesome and natural food.

It is not surprising that Europeans and Americans steadily succumb to tropical diseases, when they persist in the irrational diet which outrages their organs of digestion and elimination, especially in the hot, moist air of the tropical lowlands.

Most of the Europeans and Americans living in the tropics look askance at fruit, because they do not understand its nutritive and

hygienic value. In a system which is overloaded with waste poison, an exclusive fruit diet would naturally bring about an immediate reaction, by increasing the activity of the eliminating organs. But this cleansing effect of the fruit in bringing on a healing crisis is looked upon as something to be carefully avoided, with the result that the functions of liver, kidneys and lungs finally break down altogether.

Those who desire to go to the tropics, should purify their blood by a diet rich in alkaline salts, exercise in the open air and breathe deeply, thus building up a large reserve of vital force to draw upon in an emergency. The accumulation of waste matter in the system breaks down our vital resistance which can never be fortified by poisonous drugs but only by systemic cleansing.

The tropics produce an abundance of the most delicious fruits and nuts, which should form the larger part of the daily diet, as they supply all the elements of nutrition without overtaxing the organs of digestion and elimination. There is no reason why a man living hygienically should not keep well even in the tropical lowlands, although he may not feel quite as energetic as in the temperate zone.

Modern medical science is still engrossed in its mediaeval errors and while many physicians have abandoned the old *materia medica,* they still seem to lack a deeper understanding of the laws of life and health, because our medical colleges and universities are ruled by the spirit of conservatism. The teachings of the great pioneers of Nature Cure who have lived during the nineteenth century are not yet fully appreciated by the majority of people, but every year thousands are losing faith in drug and serum methods of treating disease and are looking for sane and natural methods of healing.

We cannot close this chapter more appropriately than by quoting the words of the late Sir William Osler, considered one of the greatest medical authorities both in America and Europe:

"Some physicians still cannot unlearn their old training. The modern treatment of disease relies very greatly on the old so-called natural methods, diet and exercise, bathing and massage—in other words, giving the natural forces the fullest scope by easy and rational nutrition, increased flow of blood, and the removal of obstructions to the excretory systems or the circulation in the tissues. Experiences have shown us that most drugs had no effect whatever on the diseases for which they were administered."

CHAPTER XIV

Regeneration Through Diet

The reader who has given preceding chapters careful consideration must come to the conclusion that in no other branch of human activity is there such tremendous and unnecessary waste as in the usual preparation of our daily food. If it were possible to gather careful statistics in this respect, the figures would be appalling. Despite the wonderful progress of science during the last century, the majority of people still seem to be lamentably ignorant of the most important factors on which health and happiness depend.

Most foods, even before they reach the consumer, have been deprived of essential mineral elements, generally in order to improve their outward appearance at the cost of their nutritive and hygienic value. The constantly increasing consumption of white flour, refined sugar, candy, confectionery, hydrogenated oils, the use of canned goods, artificially colored and sweetened drinks, is supplemented by the irrational preparation of vegetables, which destroys much of the potentiality of the alkaline organic salts. We cannot improve on nature, and all foods which we enjoy in their natural state are best adapted for our nutrition and welfare. Devitalized and demineralized foods naturally lead to overeating, as a large quantity must be consumed to satisfy the body. There are many who eat three or four times more than would be necessary if natural foods were consumed. Furthermore, a too great variety of foods is eaten at the same meal, when two or three well selected articles would be perfectly sufficient. As a result, man's vitality begins to decline at forty, when his real usefulness should last for at least another forty years.

Simplicity in living must be the keynote in the attainment of lasting mental and physical health; it is the greatest factor in the conservation of vital force and in the prolongation of life.

In the undomesticated animal world, we find that all species confine themselves to certain varieties of food, taken in their natural state, and thereby enjoy health, strength and agility

throughout their allotted span of life. Man who takes his food from every conceivable source and mostly artificially prepared, is subject to diseases and premature death.

We will now briefly consider the most prevalent dietetic systems.

The more or less exclusive meat diet is found among the inhabitants of the arctic zones, supplemented by reindeer milk and such fresh vegetables and berries as are available during the short summer season. As already mentioned, the Eskimos use almost every part of the animal, including the blood, thus insuring a supply of alkaline salts, which are lacking in the muscular tissues. Furthermore, these people take their animal foods without cooking or artificial preparation; they do not use table salt, spices and condiments, alcoholic beverages and other articles which make up the diet of modern civilized man. Nevertheless, the Eskimos, although comparatively free from diseases, are short-lived. The digestion and assimilation of meat requires a large expenditure of vital force, as all the surplus of protein has to be converted into carbohydrates before it can be utilized in the production of heat and energy.

The experiments of Dr. Max Rubner prove that the amount of protein needed daily is very small and that in the utilization of the surplus of the ingested protein about fifty per cent is lost, while carbohydrates, especially in the form of fruit sugar, are almost completely utilized. The waste resulting from the extensive use of flesh foods by civilized man not only includes the losses incidental to digestion and assimilation, but also the increased expenditure of vital force in the elimination of the poisonous waste products.

The greatest waste, however, arises from diseases which entail loss of time and efficiency. Those who think they cannot dispense with flesh foods altogether, or who are obliged by circumstances to eat meat, should not take it oftener than three times a week, or in daily amounts exceeding 4 or 5 ounces, combined with a liberal supply of vegetable salads, and should exclude starch foods at the same meal. This combination will, to a large extent, neutralize the detrimental effects of meat, which frequently comes from diseased animals.

It is not to be expected that meat eating will be entirely discarded by civilized man for several hundred years, although its use is slowly diminishing. There are three factors working con-

stantly in this direction: (1) the increasing population of the earth and the concomitant increase of land values which will force man to an extensive culture of the soil, precluding cattle raising on a large scale; (2) the increasing knowledge of man's actual position in nature, a better understanding of the laws of life and health, which will create a larger demand for natural foods, fruits, nuts and vegetables; (3) the ethical aspect of the question, which has been emphasized throughout the ages by the great thinkers and philosophers. The slaughter house, despite all sanitary measures, cannot be reconciled with a higher civilization.

The most popular diet is the *mixed diet*, generally consisting of a great variety of foods at the same meal, such as soup, meat, potatoes, pie, coffee, etc. It is the most irrational of all diets. It seems that most people classify themselves as omnivera, believing that they should take food from every conceivable source and prepared in every possible way. In countries where food is plentiful, the inhabitants put on their tables at each meal enough variety for several days, and it is customary, especially if people live on the "American Plan," to eat three "square" meals every day. Some persons eat enough at the breakfast table to last them all day; nevertheless they appear to have appetite enough for lunch and dinner. Those who have inherited a strong digestion and a large amount of vitality may be in apparently good physical condition most of the time, but they are never one hundred per cent efficient. Before they reach middle age they are afflicted with diseases of the digestive organs, chronic catarrh, rheumatism, high blood pressure, etc.

People who have been living on such a mixed diet and who discard meat without improving the balance of their food supply will receive no benefit at all from the change. With some vegetarians the meal generally consists of more or less devitalized foods, such as white flour products, badly prepared vegetables, jams, jellies, with the liberal use of all kinds of condiments. Before a radical change of diet is begun, people should undergo a several days' fast, taking nothing but water and diluted fruit juices and clean out their intestinal canal by enemas. They should then confine themselves to no more than two or three varieties of foods at the same meal. Fruits should be preferably eaten alone, to allow them to impart to the body the full effect of their great vibratory forces.

Vegetables in the form of salads, or steamed green leaf vegetables, may be combined with baked potatoes, or, in place of the latter, a few slices of whole wheat bread. With the addition of an egg, a glass of milk, or a dish of cottage cheese, this will make a very substantial and well balanced meal. If cereal foods such as whole rice make up the larger part of the meal, a few nuts or two ounces of nut butter, in the form of nut cream, may be added. A small quantity of subacid fruits, such as raisins or dates, and a few lettuce leaves may also be included in this meal. A dietetic regimen of this kind will facilitate the change from a mixed diet to a more rational one.

Those who discard meat from their diet, generally look for substitutes of all kinds. To fill this demand, a number of so-called meat substitutes have been put on the market. They are generally cooked and canned mixtures of peanuts and cereals, flavored with aromatic herbs. While such foods may be taken occasionally, they should never form a regular part of our diet. We must remember that there is not so much necessity for additional protein foods in a meatless dietary as for a liberal supply of organic salts. Vegetarians should not make the same mistakes of those living largely on flesh foods, and take too much protein into their system. In addition to fruits and vegetables a day's ration of protein for the adult performing manual work is amply supplied by either one of the following items.

10 ounces of well prepared legumes (about 4 oz. dry weight).
5 ounces of cottage cheese.
3 to 4 ounces of unroasted nut butter.

The latter may be diluted to the consistency of cream. With most children, two or three ounces of almond butter are sufficient. With a liberal supply of fresh fruits and vegetables there is no necessity for the regular use of milk.

As an intermediate diet between the ordinary mixed and the strictly vegetarian or fruitarian regimen, the so-called *lacto-vegetarian diet* may be recommended, which includes the use of all kinds of dairy products, such as milk, butter, cream, the various kinds of cheese, and eggs. Millions are invested in the dairy industry, and while the annual consumption of dairy products only amounts in money value to fifty per cent of that spent for meat, still the use of milk and eggs eventually leads to the slaughter of

the producing animals for foods. We should therefore not encourage the extensive use of dairy products, and wherever possible take our supply of protein and fat from well-masticated nuts or wholesome nut butters. Their digestibility, if taken in proper proportions and combinations, has been discussed in Chapter III. Almonds and many tropical nuts contain very little starch, and if brought into a state of emulsion are far more economical sources of fat and protein than meat and dairy products.

Grass fed cows cannot be artificially forced to yield large quantities of milk for commercial purposes, except by the introduction of highly concentrated foods, along with their natural food. The production of milk may also be increased by the special breeding of so-called milch cows. In a natural state the lactiferous glands of the cow as well as those of any other mammal are only active till teeth of the young have grown sufficiently to enable them to take solid food.

The much advertised *milk cure*—although it has certain temporary advantages, in so far as it is a *mono-diet* and taken without pasteurizing the milk—will not be of lasting benefit. Six to eight quarts of milk per day, as are often given, supply too much protein and overwork the liver and kidneys. Milk taken occasionally and in small quantities, when there is no other cooked food to be had, is certainly better than artificially prepared foods. But, if children were given more fresh and dried fruit and green leaf vegetables, there would be no necessity for large amounts of milk. Milk should be sipped slowly and preferably not mixed with any other foods except some dextrinized cereals. Eggs may be used with vegetable salads or steamed vegetables but not more than two, either raw or soft boiled, should be eaten per day.

The *strictly vegetarian diet,* excluding all animal products, will only prove satisfactory when it consists largely of uncooked foods to insure the full benefit derived from vitamines and organic salts. No matter how carefully cooked, there is always a certain amount of loss of the nutritive value of foods by heat exceeding 150° F. Nevertheless, those who have been subsisting mostly on cooked foods for years, must make the transition to natural foods gradual, until the muscular walls of the alimentary canal and the digestive juices have been sufficiently strengthened to extract the fullest amount of nourishing ingredients from the uncooked

foods. Another great advantage of natural foods is that they require thorough mastication, which is itself a great aid in thorough digestion and assimilation.

Mrs. W. S. Wilke of Los Angeles, California, a close student of dietetics, pointedly remarks in an article "Live Foods for Live People" in the *Vitality Magazine:*

"The idea of living exclusively on natural or raw foods does not appeal to the average individual, mainly because he has never fully sensed their wonderfully invigorating and life giving quality, and also because he does not realize what a large variety of natural foods there is to select from.

"I would not advise anyone who has lived entirely on cooked foods to begin as I did and try to live exclusively on natural foods. If the change is made in too radical a manner, it often leads to complete failure. I would recommend to begin with, not more than one meal of raw food a day. Before long you will develop a desire for natural food, and your very desires will prompt you to use it more exclusively. Nor would I recommend that you adhere too strictly to the one-meal-a-day plan. If you find that your desire for the other food becomes too strong, reduce your program to a meal of raw food every other day or, better still, eat a meal of cooked food on days when the natural food makes no appeal.

"It is possible to use the natural foods in combination with cooked foods, but this is not particularly advisable for several reasons. First, you are inclined to eat too little of the natural and too much of the cooked food, and sooner or later revert to an exclusively cooked food diet. But if the latter plan is resorted to, let me recommend very strongly that you eat the natural food first. This will give it an opportunity to digest more readily, for it has been proven in the laboratories of our universities that most raw foods digest in one-third or one-half the time required for the same food after cooking. Therefore, if you mix the food in a natural state with the same or similar food in a cooked state, it will not only produce gas, but the cooked food will retard the digestion of natural food. A good plan is to make the first half of your evening meal of the natural foods. Begin with green vegetables, or a salad, without having preceded it with soup or other appetizers or stimulants.

"It was two weeks after my baby was born when I first began living exclusively on natural foods. While I was in the hospital the food that was served me was such that I did not feel I could eat it, so I gave it up and used milk exclusively. But this was not practical, for using only milk made me sick as well as the child. I would not advise mothers to live on milk while nursing their children, for I do not believe that milk is a good milk-pro-

ducer. Certainly it is not a food that produces the best kind of milk.

"During my pregnancy I gave up meat and ate fruit in abundance, but I really did not realize at that time the value of the food I was eating. I was guided largely by my own desires in choosing food. I also did not follow the fallacy of eating enough for two, and from the time the child was two weeks old I lived entirely on natural foods, fruits, vegetables and nuts. For breakfast I usually ate two or three oranges. When melons were in season I made my breakfast of them. But whatever the fruit, I ate only one kind in the morning. For lunch I had fruits and nuts. I combined different fruits in a salad and followed it by a nut course. My evening meal consisted of a combination salad of carrots, turnips, parsnips, or lettuce, spinach, celery, etc. On the salad I used a dressing made of lemon juice, honey and olive oil, and finished the meal with nuts. During the time that I was nursing my baby, I occasionally ate between meals, but always fruits. In this way I had plenty of milk at all times.

"There are five in our family, and all have lived without cooked food for the past three years. I have a little boy who has not tasted cooked food during this time, and my little girl has never tasted it."

Cereals, which, next to animal products, are the most widely used food products of the world, cannot be very well used in their natural or raw state. Very few people have strong enough teeth or the time necessary for perfect mastication of cereals in which the starch exists in the raw state. Before starch can be utilized by the organism, it must change into sugar or maltose. The process of converting starch into maltose is a slow one; only a small part of the starch is thus converted by the enzymic action of the saliva, while most of the starch is made ready for assimilation in the small intestine through pancreatic action. Bread still contains a good deal of raw starch, especially in the interior of the loaf, as the enzymic action is arrested by the heat of the oven. The advantage of well-baked, whole wheat bread is that it is more easily acted upon by the digestive juices, especially if the flour has been ground fine enough. A small amount of yeast is always preferable to baking powder for raising the dough. As the action of the yeast is destroyed during the baking process, the loss by alcoholic fermentation is very small. A new process of making bread directly from the grain by a special machine, has been referred to in Chapter V, Part II. A small amount of good, wholesome bread,

or whole wheat crackers, not exceeding 4 to 6 per day, according to occupation, will be sufficient for those who feel that they cannot abandon entirely the use of cereals.

The use of cereal foods has become almost universal and it would be difficult to discard their use altogether, even in the course of time. The teeming millions of eastern Asia, for instance, depend on rice as their staple food, and if properly prepared from the whole kernel, it is the least objectionable of the cereals, as it is less acid-forming than other grains.

Starchy roots and tubers, the staple foods in many countries, are seldom eaten raw, although it is claimed that the raw potato is often used in cases of rheumatism, as its alkaline salts readily neutralize urea and uric acid. To make starchy vegetables more digestible and palatable they should be baked in the skins, and always eaten with a liberal amount of green leaf vegetables, preferably in the form of salads. There is no doubt that in the course of time, as fruit and nut culture receive more attention, the cultivation of cereals will decrease and fresh and dried fruits will gradually take their place, and these foods will furnish the body with carbohydrates in a soluble form, needing no further preparation.

The *fruitarian diet,* by which we understand a diet consisting of fruits and nuts, supplemented by such vegetables as can be relished in their natural state, is the ideal diet of man. In the fruit of trees, nature has created one of her greatest masterpieces. When eating fruit, we enjoy the full potential energy stored up by sunlight, air, water, and the elements of the soil. The electric cellular vibrations or vital electric forces are most intense in fruits, ripened in the golden sunshine, while in flesh foods, they are at their ebb, having been consumed and lost in the life processes of the animal.

There are in fruits many subtle and indefinable qualities that are not susceptible to chemical analysis, for they are too volatile to survive the laboratory process of condensation and extraction. We have a number of food extracts in which those ingredients have been condensed, which the chemist, guided by his analysis, believes to be essential. It is more than probable that such ingredients are not the most valuable, but only the coarser part. For example, how can a chemist artificially produce an apple? No amount of analysis and subsequent synthesis will enable him to do so, for, though he may be able to produce the elements in their correct

proportions, and even imitating the more complex compounds, still there is a bloom of life about the fruit that would defy his efforts.

Fruits are considered by many people as mere food accessories to be passed around the table after a regular meal. In this way all their nutritive and medicinal qualities are lost. Fruits should be regarded as true foods, able to sustain health and vigor by themselves alone. To those who are following the simple life, a meal consisting of one or two kinds of fruit is perfectly satisfying. During the seasons when fresh, ripe fruits are available, we should make full use of our opportunity and partake of as many fresh fruit meals as possible. Fresh fruits may be supplemented by unsulphured sun-dried or dehydrated fruits in preference to canned fruits. Dried fruits contain on an average from 50 to 65 per cent of fruit sugar, from 2 to 5 per cent of protein, besides an abundance of the alkaline elements, and are therefore from every point of view superior to cereals, whose place they should take as frequently as possible. Their fat content is low, but they can be supplemented by nuts or unroasted nut butters, which also furnish an additional amount of protein. Some fruits, such as the avocado and olive, contain a considerable amount of fat. Dried fruits should not be boiled, but only softened in water, which may be heated to 120° F., in cold weather.

While under present conditions we cannot live altogether rationally, still we are able, with the natural foods available all the year round, to make up a wholesome dietary conducive to health, efficiency and longevity.

In the following paragraphs a few food combinations are given, which can be easily changed to suit personal taste, seasons or occupation. Those who have to perform a large amount of physical work may simply increase the amounts of carbohydrates and fats. Those who become accustomed to the use of uncooked foods, will find that they will be able to live on much less food than when subsisting mostly on cooked foods or food mixtures containing meats, refined sugar, white flour, condiments and spices.

In the fruitarian and uncooked dietary, unroasted nut butters should take the place of meat and dairy products. Ideal salad-dressing can be made from these pure nut butters, by thoroughly mixing them with a sufficient amount of warm water to bring them

to the consistency of cream. Unroasted almond butter is the most desirable, as it does not contain any starch and, if properly diluted, can be given to infants and convalescents. Further diluted into almond milk and sweetened with a little honey, it makes a most delicious food drink.

BREAKFAST

One dozen dried black mission figs (about 5 oz.) softened in water. In cold weather, one spoonful of nut cream may be added. One sweet orange or apple.

In place of figs a similar amount of other dried fruits, such as prunes, apricots, peaches, pears, or dates may be eaten.

During the fruit season about one pound of fresh fruit should take the place of dried fruits. The fruit may be cut into slices and the nut cream used as a dressing. Three or four ripe bananas may occasionally take the place of other fruits.

DINNER—No. 1

Combination vegetable salad, consisting of

½ head of lettuce
2 tomatoes
2 stalks of celery
1 or 2 grated carrots

dressed with lemon juice and olive oil. To this salad may be added either one of the following protein foods:

1 dish of cottage cheese, about 5 oz.
2 oz. of nut butter, reduced to the consistency of cream
1 or 2 soft boiled eggs

One or two slices of whole wheat bread may be taken with this meal; or in place of the bread, one baked potato. Fresh water-cress, mustard leaves, tender spinach leaves or dandelion leaves may be used occasionally instead of lettuce.

DINNER—No. 2

Combination fruit salad, consisting of

2 ripe bananas, sliced
2 medium sized apples, sliced
1 sweet orange, sliced
2 oz. of seedless raisins
1½ to 2 oz. of grated nuts
or 2 oz. of nut cream as dressing.

No cereal foods should be taken with the fruit salad. During the fruit season berries and other fresh fruits may take the place of apples. For sweetening both vegetable and fruit salads a teaspoonful of honey may be used, if desired.

SUPPER—No. 1

One of two kinds of steamed green leaf vegetables (spinach, swiss chard, beet tops, cauliflower, mustard leaves, celery tops, cabbage, onions).

One or two baked potatoes with butter. One soft boiled egg may be eaten with this meal.

SUPPER—No. 2

Boiled whole rice with raisins and nut cream, with the addition of a few lettuce leaves, also make a good combination.

To prepare whole rice, take one cup of whole rice to three cups of water and let it come to a boil on a slow fire. Let it simmer for at least 45 minutes or more until the kernels have absorbed all the water and become soft. The best way to prepare the rice is to put it into a fireless cooker after it has been boiling for about ten minutes. In this way the rice may be left in the cooker for several hours or until it is needed.

These few meals will give the beginner some idea how to proceed intelligently in making other combinations. During the summer season when plenty of fresh fruits and vegetables are available, very little cooking, if any, should be done.

The above combinations are chiefly intended as a transition diet from the ordinary diet to a fruitarian regimen.

The following articles should be avoided, or used only when others are not available:

Flesh foods of all kinds.

Refined sugar, candy and canned foods.

White flour products (white bread, crackers, biscuits, pastries and pies).

Degerminated cereals (cornmeal, polished rice, rolled barley, polished millet, etc.). Sago and tapioca starch.

Sulphured dried fruits (apples, apricots, peaches, pears, silver prunes, etc.).

Fruit juices treated with preservatives (benzoate of soda, salicylic acid, formalin, etc.).

Pickled foods, jams and jellies. Fried foods.

Oleomargarine, preserved with benzoate of soda.

Soft drinks (artificially colored and flavored).

Salt, spices and condiments.

Alcoholic beverages, tea and coffee, cocoa and chocolate.

According to their hygienic value human foods may be classified as follows, beginning with the most desirable ones:

Fresh fruits of all kinds, in their season, if not mixed with any other foods.

Green leaf vegetables, in the form of salads.

Sun-dried or dehydrated fruits (unsulphured).

Nuts, unroasted nut butters, and cold pressed vegetable oils.

Starchy vegetables, if properly prepared.

Whole grain products and legumes.

Milk and dairy products.

Flesh foods of all kinds, the least essential of all foods, which have no place in a rational dietary.

Nature's most wholesome foods need hardly any artificial preparation. The exquisite flavors and palatableness of her luscious fruits, her tasty nuts and cooling green leaf vegetables defy the efforts of the most expert cook to improve on her incomparable handiwork. The adoption of the fruitarian diet means the emancipation of woman from kitchen slavery. It will enable her to devote the time she now spends over the hot kitchen stove in the preparation of sumptuous dinners, to the better education of her children and to her own culture.

Diet reform, which in a larger sense means the mental and physical regeneration of the individual, will be one of the greatest factors in establishing a new and better civilization, for it involves beneficial reforms which everybody can at once begin to apply to himself without waiting for the enactment of legislative measures.

We cannot rise to higher forms of life, so long as we live out of harmony with the laws of nature. To attempt to improve mankind by sumptuary mandates has proved futile. We know

that the prohibition of manufacture and sale of alcoholic beverages can never be really enforced while the people pursue their old ways of living. Prohibitionists are well meaning, but short-sighted; they do not realize that food poisoning is just as detrimental as alcohol poisoning. Many of them fall prey to disease and premature death because they overeat and indulge in strong coffee or tea. They are trying to make alcohol the scapegoat of all evils. There is no difference, except in degree, between the injurious consequences arising from an excess of the consumption of flesh foods, white flour, refined sugar, candy, etc., and that of alcohol. However, nothing could be achieved by making laws prohibiting the use of refined sugar, white flour, meat, coffee and tea. The consumption of alcoholic liquors has probably not appreciably decreased in the United States, considering the enormous development of "home brew" industry, and the flourishing illicit trade. Prohibition of any article of food or drink will always cause a large number of people addicted to its use to obtain it by illegitimate ways.

Those who change from conventional eating habits to wholesome living may, for a few weeks, feel that the plain natural foods are not satisfying them. This is due to the fact that the wholesome fare is lacking in artificial stimulating qualities. People who are suddenly deprived of their stimulants lose strength and weight. They are enervated. They do not realize that they were already enervated before they gave up their stimulating foods, which had slowly depleted their vitality.

Those who have for years lived on a mixed diet, largely meat, and then quickly changed, for the sake of experimental purposes to a vegetarian diet for a brief period, have been more or less disappointed with the results. This is understandable, for a radical change of this kind must necessarily provoke irregularities. Such experiments are of little value as they really prove nothing unless they are carried on for months or years after a careful study of dietetics. By living mostly on cooked foods, people have eaten far more than necessary, and naturally their stomach and intestines have become more or less inflated, often leaving an artificial craving for more food after their first simple and wholesome meals.

Overeating exists because such foods as bread, puddings, pies and pastries, are tasty and attractive long after a sufficiency has

been eaten. This tendency to please the palate with sugar and condiments not only induces overeating, but removes all desire for natural foods. People who have given the subject of diet no attention will inevitably drift into eating habits that create disease, for they will eat less of foods which purify the system and more of those which favor retention of waste and fail to furnish the vital cell-building materials.

As long as we have no educational system which teaches the importance of rational eating, the old dietetic evils will continue and the old errors will be handed down from generation to generation because we ourselves have been educated in the old traditions and are working under the same influences as our ancestors. But the existing state of things, however discouraging, is not permanent and the history of evolution shows that all nature works unceasingly for progress.

Man's lost instinct for natural foods will be replaced by a conscious knowledge, resulting from the study of the laws of biology and physiological chemistry as well, as by practical experience. The fact will be more and more realized that the vegetable kingdom is the store house of all nutrition, giving us the greatest variety of products from which to select our foods, enabling us to enjoy them in their natural state, full of electrical vitality, unblemished by the hand of man.

The continuous wholesale killing of animals for human food, is not only a violation of a biological law, but one of the greatest economic wastes. To be sure, this change in man's attitude toward the animal world, means a reversal of his habits of life. But the human intellect, when exercised, is a power that will correct errors of habit without serious physical disturbance.

It cannot be emphasized too often that many will at first experience a seeming change for the worse in adopting a rational vegetarian or fruitarian diet. The various disagreeable symptoms or crises, which will appear in most instances and cause so many to quickly return to their old ways of living, are really a sign of improvement. The body, which, by the old perverted dietetic habits has been encumbered with morbid matter is gradually being invigorated by the natural food and is beginning to eliminate the poisons which have for years accumulated throughout the system. This increased elimination will often be accompanied by a tem-

porary feeling of depression and fatigue. But by perseverance in the new dietary, these disagreeable symptoms will soon give way to normal and healthy reactions.

There is no victory without struggle and those who do not have the will and determination to carry out the once undertaken work of self-reformation should rather not begin at all. We realize that the physician who demands self-discipline from his patients is not very popular.

"Nothing offends patients more," writes Dr. Alexander Bryce, "than to be asked to change their habits of life. Their desire is to be able to break every known law of health; and when they are called upon to pay the penalty, they accept complete absolution in a bottle or two of medicine. They do not want to be cured, but are content to be patched up sufficiently to continue their practice of self-indulgence in various forms."

To find the fountain of eternal youth and drink from it copiously has been the dream for centuries of many who, feeling the premature decline of health and vigor, desire to renew life's forces by some mysterious magic liquid. This desire is most typically illustrated in Goethe's Faust, who in his search to regain youthfulness, after a life of dissipation, asks Mephisto:

> "Has neither nature nor a nobler mind
> A balsam yet devised of any kind?"

Mephisto answers:

> "Here is my remedy, which cures
> Without physician, gold or care:
> Drop luxury, and to the fields repair
> Begin to dig and cultivate thy square.
> Thy senses and thyself confine
> Within a small and happy sphere.
> Support thyself upon a frugal fare
> Like deer and birds, in woods and air.
> This is the surest method, without fail,
> At eighty to grow young again and hale."

But Faust, who like so many others, does not want to make the effort to follow Mephisto's sound advice, indignantly replies:

> "I cannot do this, nor can myself degrade
> So far, to work with rake and hoe and spade.
> This narrow life would suit me not at all."

Mephisto, realizing his inability to persuade Faust, finally con-

cludes to resort to magic, as nothing else would act so quickly to satisfy his impatient companion:

"The witch must then be summoned after all."

If Faust had lived several hundred years later, Mephisto, in all probability would have recommended to him a pair of new monkey or goat glands to regain his sprightliness, and to revel again in the pleasures of youth. Indeed, we see here in Faust a true picture of over-civilized mankind, who lives in self-indulgence and then prefers to get "cured" quickly by taking some mysterious pills or potions, or to undergo the knife of the surgeon rather than deviate from ingrained habits, and acquire the practice of self control and abstemiousness.

Diet reform is not as yet a very popular subject, and people are apt to listen to those who advise them to "Eat what you like or eat what agrees with you," and then feel satisfied to blame their ills on some imaginary cause. To be sure, there are many who recognize the necessity of rational nutrition, but find it difficult to change suddenly their long established habits of life. To these we must give stepping stones which will gradually lead to the adoption of a natural diet.

Few people realize what a powerful influence upon our social and economic life a change in dietetic habits would have. It would mean a new and better system of agriculture and horticulture, improved methods of production, transportation, and distribution of the world's most wholesome foods to bring them at reasonable prices within reach of all. These may seem far removed ideals, whose realization will require the intense work of many generations, but if we consider, seriously, what enormous sums we spend for insane warfare, which could be devoted to human progress and well-being, we must admit that very much could be accomplished within the present generation. With the cooperation of a few men like Burbank, Edison, Steinmetz and Ford, and sane legislative measures in regard to tenure and taxation of land, human life could be made more wholesome, more useful and enjoyable for the toiling masses than it is now.

True progress does not mean the production and consumption of luxuries, but rather the living of a simple, wholesome life, helpful to ourselves and our fellowmen. There is no necessity for living a life of asceticism, but the more simply one lives in regard to his

food, the more he will be satisfied with simplicity and frugality. As man learns to enjoy the exquisite and inimitable flavor of natural foods, the desire for all stimulants, condiments and artificially prepared dishes to tempt the palate will vanish. It is a great mistake to regard sumptuous meals as an indication of a better civilization. They really lay the foundation for individual and national decadence. On the other hand, to the degree that a simple diet becomes popular among all classes of people, the collective life of the nation will be purer and cleaner, and disease, inebriety and crime will decline.

By strictly conforming to nature's laws, man should live at least one hundred years. He should increase his physical and mental powers until he is sixty years of age, and retain them for another two score of years. Yet comparatively few instances are on record of vigorous men past sixty years of age.

With the increasing knowledge of our position in nature and the laws which govern our being, we may hopefully look forward to the time when an age of temperance, an age of sanitary reform, an age of plain living and high thinking shall have so regenerated man that he will walk the earth a century and more, carrying out the great law of evolution, which culminates in the physical and mental perfection of the human race.

APPENDIX

Explanations of the Periodic Table of Elements

The theory of the octave, as applied to the elements, later known as the Periodic Theory, was first set forth by the Russian scientist, Ivanovitch Mendeleeff. He divided the elements by parallel columns into vertical groups or octaves. The position of the different elements in the column is determined by their atomic weight, commencing with the lightest and gradually ascending the column as the atomic weight increases.

The elements in Group O, as far as has been ascertained, have no known chemical combination with any other element. The elements in Groups 1 and 2 are alkaline. The elements in 3 and 4 are either weakly alkaline, or weakly acid; the elements in Groups 5, 6 and 7, are strongly acid. By drawing parallel lines through all of the columns, attention is directed to the similarity of the elements on the parallel lines; they have similar properties and are closely related. This similarity is usually noted in each octave, but may be separated by two or more octaves. The electron makes up the atoms of all matter, the only difference being in the number of electrons, both positive and negative, that their atoms contain. Two factors govern atomic vibration: first, the increasing number of electrons contained in the atoms; and, second, the relative predominance of the negative electrons over the positive.

Explanation of the Tables of Analyses

The amounts of organic salts in 1000 parts of water free substance have been calculated by the author with the object of furnishing a means of comparing them on an equal basis with the respective amounts of total mineral matter contained in the solid material. Where no figures are given no analysis is available. Very few analyses have been made to determine the contents of manganese, fluorine and iodine in foods. For this reason these elements do not appear in the tables. Some analyses of iodine in foods are given in Part I, Chapter XIII.

Analyses of mineral matter of different foods, grown in dif-

ferent localities should be made frequently, in order to determine the variation of their mineral contents and the particular elements needed for improving both soil and food products. This is highly important, when we consider the fact that many plant diseases and insect pests are traceable to impoverished or wrongly fertilized soils.

The analyses presented in these tables have been taken mostly from the following sources:

Dr. J. Koenig, *Chemie der Menschlichen Nahrungs und Genussmittel* (Chemistry of Human Foods and Food-Accessories).

Dr. E. Wolff, *Aschen Analysen* (Analyses of Mineral Matter in Foods).

Dr. Ragnar Berg, *Die Nahrungs und Genussmittel, ihre Zusammensetzung und ihr Einfluss auf die Gesundheit mit besonderer Berücksichtigung der Aschen Bestandteile.* (Foods, their Composition and Influence upon Health, with Special Reference to their Contents of Mineral Matter.)

Dr. Henry C. Sherman, *Chemistry of Food and Nutrition.*

U. S. Department of Agriculture, Bureau of Chemistry, Bulletin No. 87, *Chemical Composition of some Tropical Fruits and their Products.*

Wilson Popenoe, *Manual of Tropical and Subtropical Fruits.*

EQUIVALENTS OF WEIGHTS AND MEASURES

Avoirdupois				*Metric*
Lb.	Oz.	Grains		Grams
2	3	119.9	=	1,000
1	..	.....	=	453.6
..	3	230.7	=	100
..	1	.....	=	28.3
..	..	15.4	=	1

1 lb.=16 oz.=7,000 grains; 1 oz.=437.5 grains.
1 kilogram=1,000 grams=15,432 grains.
1 cubic foot of water=7.48 gallons; weighs 62.5 lbs.
1 gallon of water=4.54 litres; weighs 8.3 lbs.
1 cubic foot of air at sea level and 32° F. weighs about 1⅛ oz.
1 bushel wheat=60 lbs.
1 bushel shelled corn=56 lbs.
1 bushel rye=56 lbs.
1 bushel buckwheat=52 lbs.
1 bushel oats (in the husk)=32 lbs.

MENDELÉEFF'S PERIODIC TABLE OF ELEMENTS MODIFIED

Group 8			*Iron A. W. 56 E. 43120 Nickel A. W. 58, E. 44660 Cobalt A. W. 59, E. 45430		Ruthenium 101, E. 77770 Rhodium 103, E. 79310 Palladium 106, E. 83160		Osmium A. W. 191, E. 147070 Iridium A. W. 193, E. 148610 Platinum A. W. 194, E. 149380.		
Group 7	*Fluorine A.W. 19 E14630	*Chlorine A.W. 35.5 E27335	*Manganese A.W. 55 E42350	Bromine A.W. 80 E61600		*Iodine A.W. 127 E97790			
Group 6	*Oxygen A.W. 16 E12320	*Sulphur A.W. 32 E24640	Chromium A.W. 52 E40040	Selenium A.W. 79 E60830	Molybdenum A.W. 96 E73920	Tellurium A.W. 127.1 E97867	Tungsten A.W. 184 E141680		Radium A.W. 257.8 E198506
Group 5	*Nitrogen A.W. 14 E10780	*Phosphorus A.W. 31 E23870	Vanadium A.W. 51 E39270	*Arsenic A.W. 75 E57750	Niobium A.W. 94 E72380	Antimony A.W. 120 E92400	Tantalum A.W. 183 E140910	Bismuth A.W. 208 E160160	Uranium A.W. 238 E183260
Group 4	*Carbon A.W. 12 E9240	*Silicon A.W. 28 E21560	Titanium A.W. 48 E36960	Germanium A.W. 72 E55440	Zirconium A.W. 90 E69300	Tin A.W. 119 E91630	Ce-Yb A.W.140-173 E107800-133210	Lead A.W. 206.1 E158697	Thorium A.W. 232 E178640
Group 3	Boron A.W. 11 E8470	*Aluminum A.W. 27 E20709	Scandium A.W. 44 E33880	Gallium A.W. 70 E53900	Yttrium A.W. 89 E68530	Indium A.W. 115 E88550	Lanthanum A.W. 138.1 E106337	Thallium A.W. 204 E157080	
Group 2	Glucinum A.W. 9 E6930	*Magnesium A.W. 24.4 E18788	*Calcium A.W. 40 E30800	Zinc A.W. 65 E50050	Strontium A.W. 87 E66990	Cadmium A.W. 112 E86240	Barium A.W. 137 E105490	Mercury A.W. 200 E154000	
Group 1	Lithium A.W. 7 E5390	*Sodium A.W. 23 E17710	*Potassium A.W. 39.1 E30107	Copper A.W. 63.1 E48587	Rubidium A.W. 85 E65450	Silver A.W. 108 E83160	Caesium A.W. 132.1 E101717	Gold A.W. 197 E151690	
Group 0	Helium A.W. 4 E3080	Neon A.W. 20 E15400	Argon A.W. 39 E30030		Krypton A.W. 81.1 E62447		Xenon A.W. 128 E98560		
Series	2	3	4	5	6	7	8	9	10

A.W. = Atomic Weight E = Electrons, with number of negative electrons (corpuscles) in the atom.
*Elements which are concerned with organic life; all others are only found in the inorganic state.
*Hydrogen, the lightest element, A. W. 1, E770 belongs to Group 1, Series 1.

Berries and Deciduous Fruits	Average Chemical Composition Per Cent					Composition of Mineral Matter in 1,000 Parts of Water Free Substance									
							Acid Binding Elements					Acid Forming Elements			
	Water	Protein	Fat	Carbohydrates	Mineral Matter	Total	Potassium K_2O	Sodium Na_2O	Calcium CaO	Magnesium MgO	Iron Fe_2O_3	Phosphorus P_2O_5	Sulphur SO_3	Silicon SiO_2	Chlorine
Apples	84.80	0.40	0.50	13.00	0.50	33.00	11.78	8.61	1.35	2.89	0.46	4.52	2.01	1.42	.....
Apricots	84.70	1.42	.....	13.34	0.54	33.60	19.68	3.76	1.08	1.12	0.26	3.76	0.92	2.80	0.20
Blackberries	86.30	1.30	1.00	10.90	0.45	40.15	17.90	0.60	7.95	4.75	0.05	6.20	0.90	.....	1.80
Cherries, average	79.80	1.00	0.80	16.70	0.70	34.60	17.94	0.76	2.60	1.90	0.70	5.54	1.76	3.11	0.48
Cranberries	88.90	0.40	0.60	8.40	0.40	36.00	9.00	0.03	10.15	0.90	0.04	1.60	14.20	.....	0.03
Currants, red	82.20	0.30	.....	11.30	0.45	25.00	12.10	0.04	1.46	0.95	0.03	2.17	7.95	.....	0.35
Currants, white	81.20	0.40	.....	13.60	0.44	23.50	16.90	0.16	0.29	0.45	0.05	1.40	3.95	.....	0.30
Currants, black	76.80	1.00	.....	18.70	0.51	22.30	13.70	0.13	0.60	0.75	0.04	2.27	4.73	.....	0.08
Gooseberries	85.70	0.50	.....	8.40	0.40	29.00	11.22	2.87	3.54	1.70	1.32	5.71	1.71	0.75	0.22
Grapes, average	78.20	1.30	1.25	18.60	0.65	30.00	18.75	0.40	2.70	1.25	0.45	4.00	1.50	0.60	0.35
Huckleberries	78.40	0.80	0.60	16.60	1.00	46.30	26.44	3.00	3.70	2.82	0.50	8.05	1.44	0.42	.....
Medlar	74.60	0.50	0.30	16.50	0.60	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Mirabelles	80.90	0.60	.....	13.60	0.46	24.25	13.50	1.80	1.40	1.20	0.35	4.80	1.05	.....	0.15
Mulberries	84.70	0.40	.....	14.30	0.60	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Muskmelons	89.50	0.60	.....	7.20	0.60	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Nectarines	82.90	0.60	.....	15.90	0.60	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Pears	84.40	0.60	0.50	14.10	0.40	25.60	14.00	2.17	2.05	1.52	0.25	3.90	1.45	0.38	.....
Peaches	88.10	0.70	0.10	9.40	0.48	40.70	20.90	3.00	4.60	1.35	0.50	6.05	3.50	.....	0.80
Plums	78.40	1.00	.....	20.00	0.60	27.80	16.45	0.15	2.78	1.53	0.90	4.17	1.03	0.68	.....
Prunes, average	81.20	0.80	.....	16.50	0.70	37.75	18.28	3.41	4.34	1.36	0.94	6.03	1.21	1.19	0.15
Prunes, French	80.50	0.90	.....	18.50	0.60	30.00	20.95	0.92	0.90	1.60	0.25	3.47	0.64	1.35	0.07
Raspberries, black	84.10	1.70	1.00	12.60	0.60	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Raspberries, red	85.80	1.00	.....	9.70	0.60	42.25	16.50	1.90	3.15	1.75	0.05	4.50	11.50	.....	2.90
Strawberries	87.70	1.00	0.60	7.70	0.80	65.00	13.72	18.53	9.23	.....	3.73	7.97	2.05	7.83	1.10
Watermelons	92.50	0.50	0.20	6.70	0.30	40.00	18.00	3.75	4.00	2.10	1.75	5.60	2.10	1.60	1.10

TROPICAL AND SUBTROPICAL FRUITS	AVERAGE CHEMICAL COMPOSITION PER CENT					COMPOSITION OF MINERAL MATTER IN 1,000 PARTS OF WATER FREE SUBSTANCE — ACID BINDING ELEMENTS						ACID FORMING ELEMENTS			
	WATER	PROTEIN	FAT	CARBOHYDRATES	MINERAL MATTER	TOTAL	POTASSIUM K_2O	SODIUM Na_2O	CALCIUM CaO	MAGNESIUM MgO	IRON F_2O_3	PHOSPHORUS P_2O_5	SULPHUR SO_3	SILICON SiO_2	CHLORINE
AVOCADO	68.85	1.95	21.60	6.00	1.55	...	...	...	...	...	...	...	...	...	...
BANANAS	75.30	1.30	0.60	22.00	0.80	32.40	16.10	5.60	0.68	2.40	0.07	2.85	1.20	0.80	2.70
BREADFRUIT	73.10	1.57	0.51	14.60	1.15	42.75	17.50	2.10	6.30	0.50	trace	5.10	3.75	...	1.50
CACTUS LEAVES	94.66	0.72	0.09	3.30	1.23	...	...	...	...	...	...	...	...	...	...
CACTUS FRUIT	79.20	1.40	1.30	11.70	2.70	...	...	...	...	...	...	...	...	...	...
CHERIMOYA	72.13	...	...	9.16	1.04	37.00	18.40	...	0.81	0.25	...	2.43	1.67	...	2.74
DATES, average	20.00	2.10	2.80	70.00	1.60	20.00	10.50	1.00	1.15	1.19	0.06	1.00	1.20	...	3.90
DURIAN	55.50	2.30	...	23.70	1.24	...	...	...	...	...	...	...	...	...	...
FEIJOA	83.87	1.02	0.05	11.16	0.45	...	...	...	...	...	...	...	...	...	...
FIGS, black, fresh	79.00	1.50	0.20	18.70	0.60	...	...	...	...	...	...	...	...	...	...
FIGS, black, dried	20.00	5.50	1.00	63.00	3.20	40.00	10.50	9.60	3.50	3.40	0.60	6.30	2.70	2.40	1.00
FIGS, SMYRNA, dried	18.80	4.30	0.30	74.20	2.40	29.30	17.10	0.90	3.30	1.68	0.66	3.85	1.20	...	0.61
GRAPEFRUIT	86.90	0.56	...	7.37	0.39	30.00	13.20	...	2.20	1.20	0.38	3.32	1.00	...	0.40
GUAVAS	82.90	1.30	0.70	8.00	0.50	29.40	15.47	...	0.75	0.48	...	2.44	1.05	0.30	1.55
GUAVAS, strawberry	79.42	0.76	0.95	8.05	0.77	...	...	...	...	...	...	...	...	...	...
JUJUBE	68.10	1.44	0.21	21.66	0.73	...	...	...	...	...	...	...	...	...	...
LEMONS	89.30	1.00	0.70	8.50	0.50	46.70	22.54	0.84	12.75	2.09	0.20	5.25	1.25	0.31	0.18
LIMES	85.15	0.83	...	0.58	0.98	66.00	28.38	...	5.17	1.56	...	5.70	2.24	...	2.65
LITCHI, fresh	79.08	1.15	0.20	15.30	0.54	...	...	...	...	...	...	...	...	...	...
LITCHI, dried	16.04	2.90	0.80	78.00	1.90	...	...	...	...	...	...	...	...	...	...
LOQUATS	77.90	0.20	...	20.20	1.10	...	...	...	...	...	...	...	...	...	...
MANGO	87.40	0.60	0.40	9.90	0.50	40.00	18.95	...	2.55	0.64	...	2.60	1.47	...	1.55
OLIVES, dried	30.07	5.24	51.90	10.45	2.34	33.40	27.02	2.52	2.50	0.06	0.30	0.46	0.36	0.22	0.06
ORANGES, average	86.90	0.80	0.20	11.60	0.50	38.15	18.62	0.95	8.65	2.03	0.38	4.70	2.00	0.25	0.29
PAPAYA	87.80	0.50	0.05	10.30	0.56	...	...	...	...	...	...	...	...	...	...

TROPICAL AND SUBTROPICAL FRUITS	AVERAGE CHEMICAL COMPOSITION PER CENT					COMPOSITION OF MINERAL MATTER IN 1,000 PARTS OF WATER FREE SUBSTANCE									
						ACID BINDING ELEMENTS						ACID FORMING ELEMENTS			
	WATER	PROTEIN	FAT	CARBOHYDRATES	MINERAL MATTER	TOTAL	POTASSIUM K_2O	SODIUM Na_2O	CALCIUM CaO	MAGNESIUM MgO	IRON Fe_2O_3	PHOSPHORUS P_2O_5	SULPHUR SO_3	SILICON SiO_2	CHLORINE
PAWPAW	76.60	5.20	0.90	16.80	0.50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
PERSIMMON	66.10	0.80	0.70	29.70	0.90	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
PINEAPPLE	89.30	0.40	0.30	9.70	0.30	28.60	12.55	2.20	3.10	2.10	0.40	1.40	4.15	.....	2.70
POMEGRANATE	76.80	1.50	1.60	16.80	0.60	25.90	8.00	12.25	1.65	0.90	0.06	2.50	0.20	.....	0.34
SAPODILLA	75.00	0.87	0.55	20.00	1.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
SAPOTE, white	74.74	0.87	0.55	21.75	0.47	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
SOUR SOP	80.00	1.65	0.50	14.00	0.86	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
SWEET SOP	75.12	1.53	0.54	18.15	0.80	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
STAR APPLE	88.50	2.35	1.38	4.40	0.40	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
TAMARIND	47.50	1.36	.....	31.43	1.56	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
DRIED FRUITS															
APPLES	26.10	1.60	2.20	62.00	2.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
APRICOTS	29.40	4.70	1.00	62.50	2.40	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
PEARS	16.50	2.80	5.40	66.00	2.40	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
PEACHES	20.00	3.15	0.45	50.00	2.15	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
PRUNES	22.30	2.10	.....	71.20	2.30	30.00	19.15	0.80	1.40	1.75	0.80	4.20	0.80	0.90	0.10
RAISINS	14.60	2.60	3.30	73.60	3.40	40.00	19.40	3.30	2.45	2.30	0.60	7.30	2.55	.....	2.10
CURRANTS (Zante)	17.20	2.40	1.70	74.20	4.50	54.35	30.00	3.15	1.60	1.85	0.30	12.40	3.10	.....	1.75

NUTS	AVERAGE CHEMICAL COMPOSITION PER CENT					COMPOSITION OF MINERAL MATTER IN 1,000 PARTS OF WATER FREE SUBSTANCE — ACID BINDING ELEMENTS						ACID FORMING ELEMENTS			
	WATER	PROTEIN	FAT	CARBOHYDRATES	MINERAL MATTER	TOTAL	POTASSIUM K_2O	SODIUM Na_2O	CALCIUM CaO	MAGNESIUM MgO	IRON Fe_2O_3	PHOSPHORUS P_2O_5	SULPHUR SO_3	SILICON SiO_2	CHLORINE
ACORNS, dried	4.10	8.10	37.40	48.00	2.40	25.00	16.30	0.15	1.80	1.30	0.25	3.70	1.05	....	0.45
ALMONDS	4.90	21.40	54.40	16.80	2.50	26.30	5.23	0.38	3.04	3.95	0.23	10.10	0.96	0.04	0.06
BEECHNUTS	9.09	21.70	42.50	19.20	3.86	42.00	7.20	2.18	7.73	5.94	0.42	12.81	1.03	1.13	1.03
BRAZIL NUTS	4.70	17.40	65.00	5.70	3.30	34.60	6.65	0.37	6.10	2.90	0.10	13.30	4.33	....	0.85
BUTTERNUTS	4.50	27.90	61.20	3.40	3.00	....	....	....	....	....	....	....	....	....	....
CANDLENUTS	5.90	21.40	61.70	4.90	3.30	....	....	....	....	....	....	....	....	....	....
CHESTNUTS, dried	5.90	10.70	7.00	74.20	2.20	23.40	11.40	0.28	1.07	1.87	0.14	5.50	3.00	0.04	0.01
CHUFA (Earth Almond)	2.20	3.50	31.60	60.70	2.00	....	....	....	....	....	....	....	....	....	....
COCOANUT	14.10	5.70	50.60	27.90	1.70	22.80	9.75	1.30	1.10	1.30	0.40	4.80	0.85	....	3.20
COCOANUT, desiccated	3.50	6.30	57.40	31.50	1.30	....	....	....	....	....	....	....	....	....	....
COCOANUT MILK	92.70	0.40	1.50	4.60	0.80	....	....	....	....	....	....	....	....	....	....
FILBERTS	5.40	16.50	64.00	11.70	2.40	25.25	6.65	0.20	3.60	1.98	0.46	7.30	4.46	....	0.60
HICKORY NUTS	3.70	15.40	67.40	11.40	2.10	....	....	....	....	....	....	....	....	....	....
PARADISE NUTS	2.30	22.20	62.60	10.20	2.70	....	....	....	....	....	....	....	....	....	....
PECANS	3.40	12.10	70.70	8.50	1.60	16.60	5.80	0.36	1.33	2.20	0.23	6.75	....	....	....
PINONS	3.40	14.60	61.90	17.30	2.90	30.00	5.70	0.75	2.62	4.20	0.60	13.15	....	....	....
PIGNOLIAS, Italian	6.20	33.90	48.20	7.90	3.80	....	....	....	....	....	....	....	....	....	....
PISTACHIOS	4.20	22.60	54.50	15.60	3.10	....	....	....	....	....	....	....	....	....	....
WALNUTS, Black	2.50	27.60	56.30	11.70	1.90	....	....	....	....	....	....	....	....	....	....
WALNUTS, English	2.50	18.40	64.40	13.00	1.70	17.40	2.20	0.17	0.97	2.88	0.61	10.10	0.22	0.12	0.12
WATER CHESTNUTS	12.30	4.00	1.20	50.00	1.77	20.02	12.30	trace	0.90	1.15	trace	5.10	0.45	....	0.15
PEANUTS	7.40	29.80	43.50	14.70	2.25	24.30	9.27	0.21	0.95	2.29	0.27	10.60	0.45	0.05	0.23
PEANUT BUTTER	2.10	29.30	46.50	17.10	2.20	....	....	....	....	....	....	....	....	....	....
ALMOND BUTTER	2.20	21.70	61.50	11.60	3.00	....	....	....	....	....	....	....	....	....	....

Vegetables	Average Chemical Composition Per Cent: Water	Protein	Fat	Carbohydrates	Mineral Matter	Composition of Mineral Matter in 1,000 Parts of Water Free Substance — Acid Binding Elements: Total	Potassium K_2O	Sodium Na_2O	Calcium CaO	Magnesium MgO	Iron Fe_2O_3	Acid Forming Elements: Phosphorus P_2O_5	Sulphur SO_3	Silicon SiO_2	Chlorine
Artichokes	79.24	1.80	0.14	16.70	1.10	53.00	25.32	5.38	1.75	1.55	2.00	7.40	2.60	5.30	2.06
Asparagus	93.75	1.80	0.25	2.60	0.54	86.40	20.94	14.77	9.33	3.72	2.94	16.07	5.36	9.50	5.10
Beets	87.50	1.60	0.10	9.70	1.10	88.00	38.70	9.00	5.45	2.73	0.26	8.27	6.15	7.90	9.00
Beets, red	88.00	1.20	0.20	10.10	0.50	41.65	8.45	21.60	2.50	0.10	1.00	2.55	0.50	2.00	2.95
Brussels Sprouts	85.60	3.50	0.30	6.80	1.37	95.40	31.40	0.35	2.40	2.35	0.60	20.25	35.30	....	2.75
Cabbage	90.00	1.90	0.20	4.80	1.23	123.00	45.38	11.68	21.65	4.90	0.86	11.07	17.10	1.10	10.45
Cabbage, red	90.06	1.83	0.20	5.86	0.77	77.00	17.00	9.33	21.48	3.41	0.08	3.00	9.58	0.38	10.51
Cabbage, Savoy	87.10	3.30	0.70	6.00	1.64	127.00	34.80	12.95	27.17	8.13	2.16	18.63	10.41	6.07	10.03
Carrots	87.05	1.00	0.20	9.40	0.90	69.00	25.46	14.63	7.80	3.04	0.70	8.83	4.45	1.66	3.18
Cauliflower	90.90	2.50	0.30	4.55	0.83	91.20	40.46	5.38	5.10	3.37	0.91	18.42	11.86	3.37	3.10
Celery	94.50	1.10	0.10	3.30	1.00	180.00	48.60	65.25	14.70	6.75	1.60	14.50	6.50	4.30	17.80
Celery Root	84.10	1.50	0.40	11.80	0.84	52.80	22.70	trace	6.90	3.05	0.75	6.75	2.95	2.10	8.45
Chicory Root	78.80	0.80	0.20	18.30	0.73	32.85	13.20	5.05	2.40	1.60	0.85	4.30	2.70	....	2.75
Chives	82.00	2.80	0.50	10.00	0.95	53.00	18.05	2.28	11.27	2.90	0.80	8.12	6.66	....	2.32
Collards	87.10	4.50	0.60	6.30	1.50	....	....	....	....	....	....	....	....	....	....
Cucumbers	95.60	1.20	0.10	2.30	0.44	100.00	41.20	10.00	7.30	4.15	1.40	20.20	6.90	8.00	6.60
Dandelion	85.50	2.80	0.70	7.45	1.90	131.00	50.95	13.63	26.20	11.00	1.10	10.22	2.88	9.17	3.47
Dill	83.80	3.50	0.90	7.30	2.40	142.00	28.70	12.65	31.95	11.55	1.00	20.30	20.05	2.40	14.75
Eggplant	92.90	1.20	0.30	5.10	0.50	70.00	39.05	2.80	3.05	4.20	0.25	9.50	4.45	....	6.70
Garlic	64.70	6.80	0.10	27.90	1.50	....	....	....	....	....	....	....	....	....	....
Horseradish	76.70	2.70	0.35	16.00	1.50	64.40	19.81	2.57	5.28	1.87	1.25	4.96	19.84	8.18	8.18
Jerusalem Artichoke	79.10	1.50	0.10	17.00	1.05	50.00	26.20	5.80	1.80	1.60	2.15	7.65	2.70	....	2.10
Kale	93.80	1.90	0.10	3.00	1.58	255.00	81.50	5.35	28.10	7.30	1.30	35.50	86.00	....	10.50
Kohlrabi	85.90	4.90	0.20	8.20	1.17	83.00	29.30	5.40	9.15	5.65	2.50	1.70	7.35	2.05	4.10
Leek, bulbs	87.60	2.80	0.30	6.50	1.24	100.00	30.70	14.15	10.40	2.90	7.60	16.70	7.40	7.40	3.10
Leek, leaves	90.80	1.50	0.30	5.10	0.69	75.70	33.25	5.55	17.70	3.60	0.50	6.25	3.35	....	5.50

Vegetables	Average Chemical Composition Per Cent: Water	Protein	Fat	Carbohydrates	Mineral Matter	Composition of Mineral Matter in 1,000 Parts of Water Free Substance — Acid Binding Elements: Total	Potassium K_2O	Sodium Na_2O	Calcium CaO	Magnesium MgO	Iron Fe_2O_3	Acid Forming Elements: Phosphorus P_2O_5	Sulphur SO_3	Silicon SiO_2	Chlorine
Lettuce	94.30	1.40	0.30	2.20	1.03	180.70	67.94	13.55	26.56	11.20	9.40	16.62	6.87	14.64	13.82
Lettuce, Romaine	92.50	1.54	0.43	4.20	1.33	177.60	44.90	62.70	21.10	7.60	2.30	19.40	6.90	5.30	7.40
Lettuce, Lambs'	93.40	2.70	0.40	2.70	0.79	120.00	53.00	11.20	7.20	2.60	0.45	10.20	5.80	24.00	5.70
Okra	90.20	1.60	0.20	7.40	0.60	61.35	8.80	12.00	21.00	3.30	trace	9.00	7.10	.....	.....
Onions	87.60	1.60	0.30	9.90	0.60	48.40	12.10	1.55	10.65	2.55	2.20	7.25	2.65	8.10	1.35
Parsley	85.05	3.70	0.70	7.45	1.70	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Parsnips	83.00	1.60	0.50	13.50	1.40	80.20	33.80	0.32	4.80	2.50	0.25	10.25	8.00	9.60	10.40
Pepper, green	92.00	1.10	0.10	4.60	1.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Potatoes	75.00	2.08	0.15	21.00	1.10	44.20	26.56	1.33	1.15	2.18	0.48	7.47	2.89	0.88	1.55
Potatoes, sweet	69.00	1.80	0.70	27.40	1.10	35.50	18.60	2.20	3.10	0.85	0.50	2.20	1.05	1.40	5.50
Pumpkins	90.30	1.10	0.13	6.50	0.70	72.15	13.85	15.22	5.55	2.45	1.88	23.80	1.73	5.27	0.30
Radish, large	86.90	1.90	0.10	7.40	1.07	82.30	18.00	3.05	6.60	2.85	1.00	33.70	6.35	6.75	4.00
Radish, small	93.30	1.20	0.15	3.80	0.74	110.50	35.10	23.15	16.30	3.35	3.00	12.00	7.15	1.00	10.00
Rhubarb	94.40	0.60	0.70	3.60	0.70	125.00	74.50	6.45	12.55	.....	1.84	18.41	2.34	3.46	6.81
Rutabagas	88.90	1.30	0.20	8.50	1.10	100.00	46.30	13.60	8.80	5.20	1.70	18.10	5.30	.....	1.00
Salsify	85.40	4.30	0.30	6.80	1.20	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Salsify, black	80.40	1.00	0.50	17.10	1.00	48.80	15.30	6.40	3.40	2.07	1.48	12.95	5.60	.....	1.60
Sorrel	92.20	1.70	0.30	3.90	0.98	125.80	56.05	0.85	7.00	8.70	9.85	21.35	13.30	.....	8.70
Spinach	88.50	3.50	0.60	4.44	2.10	182.60	29.90	63.90	21.50	11.50	6.05	18.05	12.45	8.10	11.30
Sugarbeets	81.30	1.00	0.10	15.80	0.70	37.40	20.15	3.35	2.30	3.00	0.45	4.60	1.60	.....	1.85
Sugarbeet Leaves	88.75	1.91	0.03	8.64	0.70	63.60	23.40	11.00	15.60	7.35	0.40	3.25	2.60	.....	.....
Swiss Chard	92.50	1.54	0.43	4.20	1.33	177.60	44.90	62.70	21.70	7.60	2.30	19.40	6.90	5.30	7.40
Tomatoes	94.00	0.90	0.20	3.75	1.05	175.00	82.50	32.90	11.35	13.55	1.00	10.75	5.00	1.75	18.00
Turnips	89.90	3.50	0.10	11.30	1.28	126.00	59.10	7.10	14.24	4.66	0.75	18.27	12.10	1.40	8.30
Turnip Leaves	.....	.....	.....	.....	.....	.....	22.63	8.16	27.39	2.78	1.29	3.71	4.38	.....	.....
Water Cress	92.30	1.90	0.10	1.30	1.46	190.00	44.75	17.25	35.00	8.60	0.35	22.40	53.90	.....	7.75

CEREALS BREADS ETC.	AVERAGE CHEMICAL COMPOSITION PER CENT					COMPOSITION OF MINERAL MATTER IN 1,000 PARTS OF WATER FREE SUBSTANCE — ACID BINDING ELEMENTS						ACID FORMING ELEMENTS			
	Water	Protein	Fat	Carbohydrates	Mineral Matter	Total	Potassium K_2O	Sodium Na_2O	Calcium CaO	Magnesium MgO	Iron Fe_2O_3	Phosphorus P_2O_5	Sulphur SO_3	Silicon SiO_2	Chlorine
Barley, whole	13.80	11.10	2.20	64.90	2.70	31.30	8.80	1.05	1.10	3.70	0.40	15.00	0.70	0.20	0.35
Barley, pearled	11.50	8.50	1.10	77.80	1.10	12.30	2.70	0.40	0.22	0.80	0.22	5.20	2.40	.....	0.35
Buckwheat	13.27	11.41	2.68	68.79	2.38	27.45	6.32	1.68	1.21	3.41	0.47	13.35	0.55	0.06	0.35
Corn, yellow, whole	13.10	9.85	4.60	68.50	1.51	18.50	6.12	0.60	0.36	2.17	0.10	5.25	2.70	0.40	0.80
Corn Meal, bolted	12.60	7.10	1.30	78.40	0.60	6.85	2.15	0.40	0.20	0.85	0.01	1.95	0.50	.....	0.80
Corn, green (on the cob)	75.40	3.10	1.10	19.20	0.70	28.45	8.50	3.20	0.50	2.65	0.07	8.28	3.68	0.50	1.12
Corn, popped	4.30	10.70	5.00	77.30	1.30	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Corn, Egyptian	14.30	10.06	3.29	68.35	2.03	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Corn, Kaffir	9.30	9.90	3.00	74.90	1.50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Corn, Milo Maize	9.00	10.70	2.80	72.20	2.30	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Millet	11.50	9.00	3.80	70.25	1.95	22.00	4.46	0.71	0.28	3.26	0.42	13.00	.....	1.60	.....
Oats, whole	12.40	10.40	5.20	57.80	3.02	34.50	10.40	1.35	2.25	4.25	0.40	14.30	0.80	0.40	0.35
Oatmeal	7.30	16.05	7.20	67.50	1.95	20.00	5.50	1.00	1.10	1.75	0.05	8.10	1.40	0.20	1.10
Oats, rolled	7.70	16.70	7.30	66.20	2.10	22.60	6.50	1.30	1.50	2.10	0.60	7.15	1.45	0.20	0.60
Rice, whole	13.10	7.85	0.88	76.50	1.00	16.00	3.60	0.67	0.59	1.78	0.22	8.60	0.10	0.40	0.02
Rice, polished	12.55	7.90	0.52	77.80	0.35	4.00	0.87	0.22	0.13	0.45	0.05	2.15	0.03	0.11	0.01
Rice, bran	12.90	11.10	7.85	62.10	4.55	52.30	6.00	.....	1.35	9.15	4.00	22.85	0.12	8.85	.....
Rye, whole	15.06	11.50	1.80	67.80	1.81	21.30	7.45	0.55	0.90	2.10	0.30	7.80	1.50	0.30	0.40
Rye, flour, bolted	12.90	6.80	0.90	78.70	0.70	8.00	2.75	0.15	0.10	0.60	0.15	3.35	0.60	.....	0.30
Rye, bran	10.90	17.40	3.70	69.06	5.00	56.10	15.75	0.75	1.95	8.80	1.40	26.70	.....	1.15	.....
Sorghum	12.80	9.10	3.60	69.80	2.10	24.00	6.00	0.90	0.35	5.20	0.58	10.60	0.12	.....	0.25
Wheat, whole, average	13.40	13.60	1.90	69.10	2.00	23.10	7.20	0.50	0.75	2.80	0.30	10.90	0.09	0.46	0.07
Wheat, white flour	12.60	10.20	0.90	74.70	0.50	5.70	1.82	0.08	0.43	0.44	0.03	2.80	.....	.....	.....
Wheat, middlings	11.73	15.22	4.77	60.55	2.85	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Wheat, bran	12.40	16.60	3.50	62.10	4.85	55.00	15.15	0.33	1.65	9.35	0.38	27.80	0.13	0.50	.....
Wheat, germ	12.50	35.70	13.10	31.20	5.70	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

CEREALS BREADS ETC.	AVERAGE CHEMICAL COMPOSITION PER CENT					COMPOSITION OF MINERAL MATTER IN 1,000 PARTS OF WATER FREE SUBSTANCE — ACID BINDING ELEMENTS						ACID FORMING ELEMENTS			
	WATER	PROTEIN	FAT	CARBOHYDRATES	MINERAL MATTER	TOTAL	POTASSIUM K_2O	SODIUM Na_2O	CALCIUM CaO	MAGNESIUM MgO	IRON Fe_2O_3	PHOSPHORUS P_2O_5	SULPHUR SO_3	SILICON SiO_2	CHLORINE
BREAD, whole wheat	35.70	8.90	1.80	52.10	1.50	23.30	4.15	4.10	1.55	1.05	0.30	4.75	0.60	.....	6.80
BREAD, white	35.30	9.20	1.30	53.10	1.10	17.00	1.50	4.90	0.40	0.48	0.03	3.20	1.80	.....	4.70
PUMPERNICKEL	42.20	4.20	0.70	43.30	1.35	23.30	2.35	6.40	1.50	2.35	0.45	4.50	0.85	.....	4.80
SWEDISH RYE CRISP	8.10	8.00	0.60	70.10	1.95	21.20	5.60	2.70	1.00	1.20	0.08	5.85	2.90	.....	1.90
SAGO	12.20	9.00	0.40	78.10	0.30										
TAPIOCA	11.40	0.40	0.10	88.00	0.10										
OILY SEEDS—															
CARAWAY SEED	13.15	19.84	18.73	7.65	5.85	67.35	17.75	4.40	12.05	5.55	2.35	16.25	3.65	3.30	2.05
MUSTARD SEED	7.18	27.59	29.66	20.83	4.47	48.15	7.80	2.90	8.75	5.05	0.50	19.25	2.40	1.20	0.25
POPPY SEED	7.50	19.40	38.40	12.80	4.27	46.10	6.27	0.46	16.30	4.50	0.18	14.48	0.74	1.52	2.12
SUNFLOWER SEED	7.50	14.20	32.30	14.50	3.50	37.80	6.12	2.80	2.87	4.65	0.60	13.38	0.87	5.54	0.90
FLAX SEED	9.20	22.60	33.70	26.89	4.30	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
HEMP SEED	8.90	18.20	32.60	21.10	4.20	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
SESAME	5.30	35.99	24.62	22.83	7.42	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
STARCHY ROOTS															
SWEET CASSAVA	66.00	1.10	0.20	30.20	0.70	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
TARO	70.90	1.80	0.20	23.20	1.20	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
YAMS	72.90	1.80	0.20	23.30	0.90	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
YAUTIA TUBERS	70.00	2.20	0.20	26.10	0.90	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
EDIBLE FUNGI—															
MUSHROOMS	89.10	2.60	0.30	6.10	0.70	64.20	32.68	1.05	0.65	2.18	1.02	21.60	2.50	0.65	0.57
CHAMPIGNONS	91.30	3.74	0.15	3.50	0.50	74.70	37.87	1.27	0.55	0.37	0.85	11.50	18.15	1.05	3.45
TRUFFLES	77.60	7.70	0.50	6.60	1.92	83.30	31.50	1.50	8.15	1.05	4.65	27.65	5.00	0.20	1.10

N. B. The large amount of Sodium and Chlorine in Bread is caused by the addition of table salt.

LEGUMES	AVERAGE CHEMICAL COMPOSITION PER CENT					COMPOSITION OF MINERAL MATTER 1,000 PARTS OF WATER FREE SUBSTANCE CONTAIN	ACID BINDING ELEMENTS					ACID FORMING ELEMENTS			
	WATER	PROTEIN	FAT	SUGAR, STARCH	MINERAL MATTER	TOTAL	POTASSIUM K_2O	SODIUM Na_2O	CALCIUM CaO	MAGNESIUM MgO	IRON Fe_2O_3	PHOSPHORUS P_2O_5	SULPHUR SO_3	SILICON SiO_2	CHLORINE
BEANS, dried	14.76	24.30	1.60	49.00	3.26	38.20	15.85	0.42	1.91	2.73	0.19	14.86	1.30	0.25	0.69
BEANS, Blackeye	8.48	21.43	1.28	61.28	4.78	....	....	....	....	....	....	....	....	....	4.78
CHICK PEAS (Garbanzas)	14.80	13.00	1.60	51.50	3.76	44.25	8.10	0.40	1.45	18.35	0.80	13.10	1.10	....	0.95
COW PEAS, dried	13.00	21.40	1.40	60.80	3.40	39.10	21.00	2.40	1.50	3.15	....	6.85	3.60	....	0.60
HORSE BEANS	14.00	18.00	0.50	50.50	2.75	32.00	15.25	0.40	0.15	0.30	0.10	14.30	1.15	....	0.60
KIDNEY BEANS, dried	13.60	23.12	2.28	53.63	3.53	40.85	18.00	0.58	2.60	3.00	0.13	14.30	1.65	0.23	0.34
KIDNEY BEANS, green	84.10	3.90	0.20	8.30	0.70	44.00	23.30	1.70	2.75	1.65	0.05	5.65	7.00	....	1.90
LENTILS	12.35	25.70	1.90	53.30	3.04	34.70	11.60	4.60	2.10	0.90	0.60	12.20	1.20	....	1.50
LIMA BEANS, dried	10.40	18.10	1.50	65.90	4.10	45.00	27.60	4.10	1.25	3.10	0.01	6.10	2.60	....	0.04
LIMA BEANS, green	68.50	7.10	0.70	22.00	1.70	54.00	33.90	4.75	1.40	3.60	0.14	6.60	3.10	....	0.50
PEAS, dried	15.00	22.85	1.80	52.40	2.58	30.03	13.06	0.30	1.45	2.42	0.24	10.87	1.03	1.27	0.53
PEAS, green	74.60	7.00	0.50	16.90	1.00	39.50	15.40	1.10	1.60	2.80	0.04	11.20	6.00	....	1.40
ST. JOHN'S BREAD	17.30	5.70	1.10	67.00	2.50	....	....	....	....	....	....	....	....	....	....
SOY BEANS	10.75	34.00	16.80	33.70	4.75	53.22	24.65	0.60	3.45	3.45	0.28	17.50	2.65	0.27	0.40
STRING BEANS, fresh	84.10	3.90	0.20	8.30	1.20	75.00	32.00	1.75	7.50	6.25	0.05	6.50	12.75	....	7.10
MISCELLANEOUS—															
HONEY	18.20	0.40	....	81.20	0.20	2.80	0.02	0.10	2.35	0.01	0.12	0.18	0.01	....	0.01
RAW SUGAR	2.16	0.30	....	94.60	0.96	9.80	5.97	1.30	0.70	0.03	0.04	0.03	0.95	....	0.78
SUGAR CANE	75.40	1.50	0.55	21.82	0.70	28.40	....	....	....	....	....	....	....	....	....
MOLASSES	25.10	2.40	....	69.30	3.20	42.70	27.00	0.38	4.22	1.36	0.02	0.88	2.58	....	6.34
COCOA BEANS	3.60	12.00	49.30	26.40	3.50	36.00	12.96	0.82	1.95	4.00	0.02	13.95	1.25	0.55	0.30
COCOA	6.30	21.50	27.30	31.60	5.20	....	....	....	....	....	....	....	....	....	....
CHOCOLATE	3.60	2.40	20.00	58.50	1.55	16.80	6.14	0.13	1.00	3.20	0.03	4.80	0.95	....	0.55
MAPLE SYRUP	27.00	....	....	71.40	0.39	5.35	2.80	0.13	1.43	0.45	0.04	0.20	0.07	....	0.13
OLEOMARGARINE	9.10	0.50	84.50	....	1.65	18.10	0.60	6.70	....	....	....	0.40	....	....	10.40

MILK (HUMAN AND ANIMAL) AND DAIRY PRODUCTS	AVERAGE CHEMICAL COMPOSITION PER CENT					COMPOSITION OF MINERAL MATTER IN 1,000 PARTS OF WATER FREE SUBSTANCE		ACID BINDING ELEMENTS				ACID FORMING ELEMENTS			
	WATER	PROTEIN	FAT	CARBOHYDRATES	MINERAL MATTER	TOTAL	POTASSIUM K_2O	SODIUM Na_2O	CALCIUM CaO	MAGNESIUM MgO	IRON Fe_2O_3	PHOSPHORUS P_2O_3	SULPHUR SO_3	SILICON SiO_2	CHLORINE
HUMAN	87.75	1.60	3.95	6.25	0.45	34.70	11.73	3.16	5.80	0.75	0.07	7.84	0.33	0.07	6.38
COW'S	87.30	3.55	3.70	4.88	0.71	55.50	13.70	5.34	12.24	1.69	0.30	15.79	0.17	0.02	8.04
DOG'S	75.60	11.20	9.60	3.10	1.35	55.30	5.70	3.25	18.20	0.80	0.08	19.75	0.25	0.15	6.55
SWINE'S	82.30	5.90	6.90	3.80	1.10	65.00	9.35	6.95	21.35	1.20	0.25	16.20	0.30	0.25	9.15
SHEEP'S	80.80	6.50	6.90	4.90	0.90	47.40	5.03	4.65	11.70	2.15	0.17	17.70	0.20	0.10	5.70
GOAT'S	85.70	4.30	4.50	4.40	0.80	70.00	15.60	3.45	13.90	2.30	0.60	21.05	0.30	0.20	13.50
MARE'S	91.50	1.30	1.20	5.70	0.41	48.20	12.05	1.60	14.25	1.50	0.20	15.00	0.15	0.05	3.55
RABBIT'S	69.40	15.50	10.50	2.00	2.60	85.00	11.40	7.75	33.60	1.75	0.07	22.80	0.40	0.30	7.00
BUFFALO'S	82.20	4.40	7.10	4.70	0.85	48.00	6.60	2.88	15.95	1.50	0.08	16.15	1.37	.....	3.47
CAMEL'S	87.10	3.60	2.70	5.30	0.75	58.15	10.50	2.00	15.48	2.70	0.12	17.20	2.05	.....	8.10
COW BUTTER	11.00	1.00	85.00	.....	3.00	33.70	1.75	12.10	0.90	0.18	0.05	0.12	6.85	.....	11.75
BUTTERMILK	90.00	3.00	0.50	4.80	0.70	77.00	18.10	8.50	14.40	2.60	0.60	21.80	1.30	.....	9.70
CREAM	74.00	2.50	18.50	4.50	0.50	19.20	5.15	1.55	4.25	0.60	0.50	3.90	0.45	.....	2.00
SKIM MILK	90.50	3.40	0.30	5.10	0.70	73.70	22.60	7.10	15.20	2.20	0.60	13.40	2.40	.....	10.20
WHEY	93.80	0.60	0.07	5.10	0.44	71.00	21.85	9.75	13.65	0.25	0.40	12.00	1.90	.....	11.20
CONDENSED MILK	68.20	9.60	9.30	11.20	1.70	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
COTTAGE CHEESE	72.50	20.90	1.00	4.30	1.25	45.00	5.40	0.90	14.35	1.00	0.30	15.35	0.60	.....	7.10
CHEESE, average	38.80	23.75	30.00	1.50	4.50	73.50	2.70	17.90	27.60	1.10	0.04	20.20	7.76	.....	26.20
EGGS, whole	73.70	12.55	12.10	0.55	1.10	41.80	6.27	9.56	4.56	0.46	0.17	15.72	0.13	0.13	3.72
WHITE OF EGGS	85.75	12.70	0.25	0.70	0.60	42.10	13.21	13.30	1.18	1.18	0.25	1.85	0.88	0.45	12.08
YOLK	50.80	16.20	31.95	0.10	1.10	24.40	2.70	1.44	3.17	0.51	0.40	15.22	.....	0.21	0.45
SEA FOODS—															
CRABS	77.10	16.60	2.00	1.20	3.10	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
MUSSELS	84.20	8.70	1.10	4.10	1.90	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
SHRIMPS	70.80	25.40	1.00	0.20	2.60	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

HUMAN BODY AND ANIMAL FOODS	AVERAGE CHEMICAL COMPOSITION PER CENT					COMPOSITION OF MINERAL MATTER 1,000 PARTS OF WATER FREE SUBSTANCE CONTAIN — ACID BINDING ELEMENTS						ACID FORMING ELEMENTS				
	WATER	PROTEIN	FAT	CARBOHYDRATES (SUGAR, STARCH)	MINERAL MATTER	TOTAL	POTASSIUM K_2O	SODIUM Na_2O	CALCIUM CaO	MAGNESIUM MgO	IRON Fe_2O_3	PHOSPHORUS P_2O_5	SULPHUR SO_3	SILICON SiO_2	CHLORINE	FLUORINE
HUMAN BODY, whole..	60.00	19.00	15.00	1.00	5.00	125.00	3.30	3.00	70.50	2.15	0.70	32.15	4.10	1.00	7.00	1.10
RED BLOOD CORPUSCLES.....	68.78	30.20	.....	.....	1.02	35.00	13.82	5.87	0.55	0.30	5.00	3.50	0.28	trace	5.68	.....
BLOOD PLASMA.......	90.00	9.00	.....	0.15	0.85	85.00	3.30	36.75	3.20	2.35	.....	1.75	1.45	0.22	36.20	.....
BLOOD SERUM.......	90.75	8.24	.....	0.15	0.86	94.50	3.60	41.80	3.50	2.45	.....	1.60	1.55	0.22	40.00	.....
LYMPH.............	94.00	4.00	0.40	0.05	0.73	121.60	3.93	57.88	1.17	0.31	0.06	1.32	.....	0.50	54.75	.....
LUNGS.............	80.00	15.20	3.65	.....	1.90	95.00	1.24	24.70	1.80	3.04	0.30	46.07	1.32	0.36	6.17	.....
BRAIN.............	80.60	8.50	9.30	.....	1.10	56.70	19.50	6.80	0.40	0.70	0.16	27.30	0.42	0.07	4.35	.....
LIVER.............	71.55	20.00	3.65	3.25	1.55	54.50	13.90	7.90	1.97	0.11	1.44	27.30	0.50	0.14	1.26	.....
SPLEEN............	75.50	17.10	4.20	1.00	1.56	63.80	6.12	28.26	4.77	0.30	4.64	17.26	1.55	0.11	0.35	.....
BILE..............	86.00	.....	.....	.....	0.85	60.00	2.88	30.35	0.85	0.32	0.14	6.27	3.83	0.21	15.06	.....
FRESH BONES........	(Dry fat free substance)					650.00	.....	.....	240.00	8.00	10.00	345.00	.....	.....	12.00	15.00
FRESH MUSCLE TISSUE	75.50	18.70	3.70	1.00	1.10	49.00	18.00	2.80	0.40	1.80	0.20	22.00	0.60	0.40	2.80	.....
BLOOD OF BULLOCKS..	80.80	18.10	0.20	0.05	0.85	44.30	3.29	19.80	0.48	0.26	4.14	2.31	1.34	0.35	15.14	.....
BLOOD OF CALF......	83.56	15.20	0.13	0.30	1.09	70.30	7.15	27.00	1.18	0.80	5.46	5.10	0.76	.....	22.90	.....
BLOOD OF SHEEP.....	79.80	19.02	0.18	0.20	0.98	52.00	3.45	22.00	0.56	0.30	4.70	2.70	0.90	.....	17.45	.....
BLOOD OF HOG.......	76.89	22.23	0.19	.....	0.79	36.20	8.00	10.00	0.45	0.46	3.04	4.15	0.35	.....	9.75	.....
MEAT, average.......	72.00	20.00	5.00	0.40	1.10	40.00	16.65	1.44	1.12	1.28	0.15	17.00	0.64	0.44	1.56	.....
BEEF..............	76.00	18.00	5.00	.....	1.00	41.70	15.24	2.70	0.08	1.00	0.18	7.02	3.10	.....	2.35	.....
PORK..............	75.00	20.25	6.80	.....	0.72	29.10	9.37	5.76	0.30	1.03	.....	7.86	3.02	.....	1.77	.....
CHICKEN...........	72.20	21.30	4.55	0.75	0.90	32.85	14.72	3.00	0.35	1.17	.....	8.00	3.70	.....	1.90	.....
SEA FISH, average....	80.00	18.00	0.80	.....	1.20	60.00	18.55	4.50	1.50	2.00	0.05	13.50	13.40	.....	6.50	.....
PIKE..............	79.60	17.90	0.50	.....	1.22	60.00	14.80	12.00	4.50	2.25	.....	23.00	0.55	.....	2.90	.....
SALMON, fresh........	64.00	20.05	12.30	.....	1.77	49.15	8.70	4.90	3.10	3.40	0.40	7.30	13.75	.....	7.60	.....
OYSTERS, fresh.......	86.90	6.20	1.20	3.70	1.47	116.50	6.70	34.10	3.80	2.75	0.30	11.50	13.00	.....	44.50	.....
CLAMS.............	85.80	8.60	1.00	2.00	2.60	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
LOBSTER...........	79.20	16.40	1.80	0.40	2.20	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

TABLE SHOWING VARIATION OF MINERAL MATTER IN FOOD PRODUCTS OF THE SAME KIND

	COW'S MILK 4 ANALYSES BY WEBER & HAIDLEN			GRAPES 18 ANALYSES BY CARTER BELL			POTATOES 53 ANALYSES BY DR. E. WOLFF			PEAS 41 ANALYSES BY DR. KOENIG		
	MINIMUM	MAXIMUM	MEAN	MINIMUM	MAXIMUM	MEAN	MINIMUM	MAXIMUM	MEAN	MINIMUM	MAXIMUM	MEAN
TOTAL MINERAL-MATTER IN FOOD, per cent	0.35	1.21	0.71	0.36	0.70	0.50	0.42	1.46	0.97	1.76	3.49	2.65
COMPOSITION OF TOTAL MINERAL MATTER, per cent:												
POTASH	17.09	33.25	24.67	31.23	54.24	42.14	43.95	73.61	60.37	35.80	51.41	42.79
SODA	8.60	11.18	9.70	0.29	10.54	3.37	....	16.93	2.62	....	3.54	0.96
LIME	17.31	27.55	22.00	1.70	22.60	9.20	0.51	6.23	2.57	2.21	7.90	4.99
MAGNESIA	1.90	4.10	3.05	0.96	12.57	9.67	1.32	13.58	4.69	5.80	13.02	7.96
OXIDE OF IRON	0.33	0.76	0.53	0.05	1.68	0.63	0.04	7.18	1.18	....	3.83	0.86
PHOSPHORIC ACID	27.04	29.13	28.45	2.20	22.37	11.12	8.39	27.14	17.33	29.30	44.41	36.43
SULPHURIC ACID	trace	2.50	0.30	3.14	13.68	9.14	0.44	14.89	6.49	....	9.46	3.61
SILICA	trace	0.04	0.02	0.08	0.98	0.29	trace	8.11	2.13	....	3.02	0.86
CHLORINE	9.87	16.96	14.28	0.29	3.39	1.09	0.85	10.75	3.11	....	6.50	1.54

(Referring to Chapter XI, Part I.)

APPROXIMATE AMOUNT OF FOOD MATERIAL NECESSARY TO SUPPLY TWO OUNCES (56 GRAMS) OF PROTEIN

Shelled Nuts

Pignolias	6 oz.
Black Walnuts	7 oz.
Butternuts	7 oz.
Peanuts	7 oz.
Almond Butter	8 oz.
Almonds	9 oz.
Pistachios	9 oz.
Beechnuts	10 oz.
Brazil Nuts	11 oz.
English Walnuts	11 oz.
Filberts	12½ oz.
Piñons	14 oz.
Pecans	16 oz.
Chestnuts	20 oz.
Cocoanuts, dried	30 oz.

Legumes and Cereals

Soy Beans, dried	6 oz.
Beans, dried	8 oz.
Lentils, dried	8 oz.
Peas, dried	9 oz.
Lima Beans, dried	10 oz.
Green Peas	30 oz.
Whole Wheat	14 oz.
Rye	17 oz.
Barley	18 oz.
Oats	19 oz.
Corn	20 oz.
Millet	21 oz.
Rice	25 oz.
Whole Wheat Bread	20 oz.
Rye Bread	21 oz.
White	21 oz.

Fresh Fruits

Paw Paws	2½ lbs.
Avocados	4 lbs.
Raspberries	7 lbs.
Apricots	8 lbs.
Figs, average	8 lbs.
Blackberries	10 lbs.
Grapes, average	10 lbs.
Bananas	10 lbs.
Guavas	10 lbs.
Cherries	12 lbs.
Strawberries	12 lbs.
Plums	12 lbs.
Huckleberries	15 lbs.
Peaches	15 lbs.
Prunes	15 lbs.
Oranges	15 lbs.
Pears	20 lbs.
Gooseberries	23 lbs.
Apples, average	25 lbs.

Dried Fruits

Raspberries	1¾ lbs.
Apricots	2 lbs.
Carobs	2 lbs.
Olives	2 lbs.
Black Figs	2¼ lbs.
Currants (Zante)	2½ lbs.
Raisins	3 lbs.
Prunes	3 lbs.
Pears	3½ lbs.
Peaches	4 lbs.
Dates	4 lbs.
Litchi Nuts	4 lbs.

Vegetables

Kohlrabi	2½ lbs.
Salsify	2¾ lbs.
Spinach	3½ lbs.
Turnips	3½ lbs.
Savoy Cabbage	3¾ lbs.
Green Corn	4 lbs.
Cauliflower	5 lbs.
Asparagus	6½ lbs.
Potatoes	7 lbs.
Beets	8 lbs.
Onions	8 lbs.
Okra	8 lbs.
Lettuce	8½ lbs.
Cucumbers	10 lbs.
Eggplant	10 lbs.
Celery	11 lbs.
Pumpkins	11 lbs.
Carrots	12½ lbs.
Tomatoes	13½ lbs.

Animal Foods

Human Milk	5 pints
Cow's Milk	3½ pints
8 Eggs	16 oz.
American Cheese	7 oz.
Swiss Cheese	7 oz.
Lean Meat	9 oz.
Cottage Cheese	10 oz.
Meat, average	10 oz.
Sea Fish, average	10 oz.
Lobster	12 oz.
Clams	25 oz.
Oysters	32 oz.

THE PROTEIN QUESTION

The protein question has been a point of controversy among dietitians ever since the days of Baron von Liebig and Dr. Voit who proclaimed the daily protein requirement of the average man as 118 grams (over 4 ounces). The careful investigations of Dr. Max Rubner, Director of the Hygienic Institute of the University of Berlin, have shown that only four per cent of the entire amount of calories consumed in the body are required in the shape of protein; while natural sugars and fats have to make up the balance. For instance, if a man consumes 2,500 calories daily, 100 calories, or about one ounce of protein, are sufficient. By living on a well balanced fruitarian diet, insuring an adequate supply of organic salts and vitamins, 1½ ounces of protein daily are more than ample even during periods of muscular exertion. For the average person doing light indoor work, one ounce of protein is sufficient, so that the amounts given in the accompanying table can be safely reduced from 25 to 50 per cent.

The fact that meat protein often shows a higher coefficient of digestibility than vegetable protein does not prove its superior value in the actual rebuilding of the living tissues of the human body. In protein coming from the tissues of the dead animal the vibratory forces of life are on the descendency, while in the living protoplasm of the natural products of the vegetable kingdom they are on the ascendency. The excessive consumption of protein, especially in the form of meat, increases the acidity of blood, favors the accumulation of toxins in the system and is laying the foundation of many diseases, like constipation, diabetes, cancer, etc., which are built slowly and often imperceptibly in the course of years.

AVERAGE PERCENTAGE OF PROTEIN CONTAINED IN WATER-FREE SUBSTANCES

Apples	2.60	Corn	11.20	Savoy Cabbage	26.00
Gooseberries	3.50	White Flour	11.60	Peas	26.90
Huckleberries	3.70	Oats	11.90	Cow's Milk	27.00
Pears	4.00	Rutabagas	12.00	Cucumbers	27.30
Prunes	4.40	Cocoabeans	12.40	Cauliflower	27.70
Plums	4.70	Pecans	12.40	Beans	28.60
Pineapples	4.80	Green Corn	12.60	Asparagus	28.80
Cherries	5.00	Barley	12.70	Lentils	29.30
Mango	5.00	Beets	12.80	Salsify	29.40
Watermelons	5.20	Onions	12.90	Butternuts	29.50
Muskmelons	5.80	Rye	13.50	Spinach	30.00
Grapes	6.00	Whey	14.00	Nettles	31.20
Oranges	6.10	White Bread	14.20	Yolk of Egg	32.00
Peaches	6.60	Radishes	14.70	Peanuts	32.20
St. John's Bread	6.80	Whole Wheat	15.70	Buttermilk	33.00
Guavas	7.00	Okra	15.80	Collards	34.50
Raspberries	7.00	Tomatoes	15.80	Turnips	35.00
Watermelons	7.20	Eggplant	17.00	Kohlrabi	35.00
Figs	7.40	Human Milk	18.00	Skim Milk	35.80
Olives	7.50	Brazil Nuts	18.30	Pignolias	36.10
Carrots	7.70	Garlic	19.00	Soy Beans	38.10
Potatoes	8.00	Dandelions	20.00	Champignons	42.00
Apricots	8.70	Celery	20.00	Cottage Cheese	74.50
Blackberries	8.80	Lima Beans	20.00	Meat, average	80.00
Rice	9.00	Swiss Chard	20.40	Blood of Bullocks	85.00
Artichokes	9.00	Chives	21.70	Blood Serum of Man	89.00
Parsnips	9.00	Almonds	22.50	White of Egg	89.00
Currants	10.00	Leeks	22.60	Fish, average	90.00
Raspberries, black	10.00	Brussels Sprouts	23.80	Red Blood Corpuscles	97.00
Rhubarb	10.00	Mushrooms	23.80		
Millets	10.00	Lettuce	24.50		
Pumpkins	11.00	Cowpeas	24.60		

SODIUM (Na_2O)

Contained in 1000 parts of water-free substance

White Flour	0.08	Sorghum	0.90	Watermelons	3.75	Pike	12.00
Honey	0.10	Oranges	0.95	Apricots	3.76	Dill	12.65
Chocolate	0.13	Dates	1.00	Chives	4.20	Savoy Cabbage	12.95
Maple Sugar	0.13	Oatmeal	1.00	Sea Fish	4.50	White of Eggs	13.30
Rye Flour, bolted	0.15	Mushrooms	1.05	Lentils	4.62	Lettuce	13.55
Walnuts	0.17	Barley	1.05	Salmon	4.90	Dandelions	13.63
Peanuts	0.21	Champignons	1.27	Cow's Milk	5.34	Leeks	14.15
Chestnuts	0.28	Cocoanuts	1.30	Artichokes	5.38	Carrots	14.63
Wheat Bran	0.33	Rolled Oats	1.30	Cauliflower	5.38	Asparagus	14.77
Pecans	0.36	Raw Sugar	1.30	Kohlrabi	5.40	Pumpkins	15.22
Almonds	0.38	Beechnuts	2.17	Beans	5.60	Strawberries	18.53
Barley, pearled	0.38	Pears	2.18	Red Blood Corpuscles	5.87	Blood of Bullocks	19.80
Grapes	0.40	Olives	2.52	Turnips	7.10	Radishes	23.37
Beans	0.42	Horseradish	2.57	Chicken Meat	8.20	Lungs	24.70
Whole Wheat	0.50	Gooseberries	2.87	Apples	8.01	Spleen	28.26
Filberts	0.65	Huckleberries	3.00	Beets	9.00	Bile	30.35
Whole Rice	0.67	Currants, Zante	3.15	Red Cabbage	9.33	Oysters	34.10
Rye Bran	0.75	Human Milk	3.16	Whole Egg	9.56	Blood Plasma	36.75
Cherries	0.76	Corn, Green	3.20	Whey	9.75	Blood Serum	41.80
Cocoabeans	0.82	Nettles	3.28	Cucumbers	10.00	Spinach	57.42
Lemons	0.84	Raisins	3.30	Dried Figs	10.77	Lymph	57.88
Sorrel	0.85	Tomatoes	3.40	Cabbage	11.68	Swiss Chard	62.70
Cottage Cheese	0.90	Prunes	3.41				

CALCIUM (CaO)

Contained in 1000 parts water-free substance

White Bread	0.10	Barley, whole	1.10	Beans	1.91	Blood Serum	3.50	Kohlrabi	9.15
Rye Flour, bolted	0.10	Cocoanut	1.10	Cocoabeans	1.95	Gooseberries	3.54	Strawberries	9.23
Rice, polished	0.13	Oatmeal	1.10	Rye Bran	1.95	Huckleberries	3.70	Asparagus	9.33
Cornmeal, bolted	0.20	Meat, average	1.12	Filberts	2.05	Oysters	3.80	Leek Bulbs	10.40
Barley, pearled	0.22	Dates	1.15	Pears	2.05	Watermelons	4.00	Onions	10.65
Sorghum	0.35	Potatoes	1.15	Lentils	2.18	Molasses	4.22	Cow's Milk	12.24
Corn	0.36	White of Egg	1.18	Mushrooms	2.18	Prunes	4.34	Lemon	12.75
White Flour	0.43	Buckwheat	1.21	Oats, whole	2.25	Pike	4.50	Whey	13.65
Red Blood Corpuscles	0.55	Pecans	1.33	Honey	2.35	Whole Egg	4.56	Turnips	14.24
Whole Rice	0.59	Apples	1.35	Raisins	2.45	Parsnips	4.80	Cottage Cheese	14.35
Bananas	0.68	Rice Bran	1.35	Olives	2.50	Cauliflower	5.10	Radishes	15.45
Raw Sugar	0.70	Chicken Meat	1.40	Pineapples	2.50	Tomatoes	5.20	Poppy Seed	16.30
Whole Wheat	0.75	Maple Syrup	1.43	Mango	2.55	Horseradish	5.28	Chives	20.70
Guavas	0.75	Peas	1.45	Cherries	2.60	Pumpkins	5.55	Swiss Chard	21.10
Whole Rye	0.90	Cowpeas	1.50	Pine Nuts	2.62	Human Milk	5.88	Red Cabbage	21.48
Peanuts	0.95	Pumpernickel	1.50	Grapes	2.70	Bread Fruit	6.30	White Cabbage	21.65
Walnuts	0.97	Rolled Oats	1.50	Brazilnuts	2.75	Celeriac	6.90	Spinach	22.73
Chocolate	1.00	Sea Fish	1.50	Plums	2.78	Sorrel	7.00	Dandelions	26.20
Rye Crisp	1.00	Whole Wheat Bread	1.55	Almonds	3.04	Cucumbers	7.30	Lettuce	26.56
Chestnuts	1.07	Currants, Zante	1.60	Salmon	3.10	Beechnuts	7.73	Savoy Cabbage	27.17
Apricots	1.08	Wheat Bran	1.65	Yolk of Egg	3.17	Carrots	7.80	Dill	31.95
		Artichokes	1.75	Blood Plasma	3.20	Truffles	8.15	Water Cress	35.00
				Figs	3.30	Oranges	8.65	Nettles	38.58

IRON (Fe_2O_3)

Contained in 1000 parts water-free substance

Chicken	trace	Almonds	0.23	Whey	0.40	Mushrooms	1.02
Pike	trace	Pecans	0.23	Oats	0.41	Dandelions	1.18
Pork	trace	Peas	0.24	Millets	0.42	Horseradish	1.25
Cocoabeans	0.02	Acorns	0.25	Grapes	0.45	Gooseberries	1.32
Molasses	0.02	White of Egg	0.25	Apples	0.46	Rye Bran	1.40
Chocolate	0.03	Pears	0.25	Buckwheat	0.47	Cucumbers	1.40
White Flour	0.03	Rye	0.25	Brazil Nuts	0.50	Chives	1.50
Maple Syrup	0.04	Parsnips	0.25	Huckleberries	0.50	Watermelons	1.75
Cheese	0.04	Apricots	0.26	Barley	0.53	Pumpkins	1.88
Sea Fish	0.05	Beets	0.26	Figs	0.60	Artichokes	2.00
Polished Rice	0.05	Peanuts	0.27	Raisins	0.60	Savoy Cabbage	2.16
Dates	0.06	Cottage Cheese	0.30	Sunflower Seed	0.60	Onions	2.20
Bananas	0.07	Oysters	0.30	Walnuts	0.61	Swiss Chard	2.30
Human Milk	0.07	Pineapples	0.30	Lentils	0.69	Asparagus	2.94
Red Cabbage	0.08	Currants, Zante	0.30	Cherries	0.70	Radishes	3.00
Whole Corn	0.10	Cow's Milk	0.30	Carrots	0.70	Strawberries	3.73
Honey	0.12	Whole Wheat	0.30	Celeriac	0.75	Rice Bran	4.00
Chestnuts	0.14	Filberts	0.35	Turnips	0.75	Truffles	4.65
Meat, average	0.15	Wheat Bran	0.38	Chickpeas	0.80	Red Blood Corpuscles	5.00
Corn	0.15	Oranges	0.38	Cabbage	0.86	Spinach	6.05
Whole Egg	0.17	Barley	0.40	Champignons	0.88	Nettles	6.57
Poppy Seed	0.18	Yolk of Egg	0.40	Plums	0.90	Leeks	7.60
Beans	0.19	Salmon, fresh	0.40	Cauliflower	0.91	Lettuce	9.40
Lemons	0.20	Beechnuts	0.40	Prunes	0.94	Sorrel	9.85
Pearled Barley	0.22	Cocoanut	0.40	Dill	1.00	Hematin, red coloring matter of the blood	66.50
Whole Rice	0.22	Pineapple	0.40	Tomatoes	1.00		

PHOSPHORUS (P_2O_5)

Contained in 1000 parts of water-free substance

Raw Sugar	0.03	Avocados	3.52	Prunes	6.03	Carrots	8.83	Cocoabeans	13.95	Cauliflower	18.42
Cow Butter	0.12	Acorns	3.70	Peaches	6.05	Okra	9.00	Oats, whole	14.30	Savoy Cabbage	18.63
Honey	0.18	Turnip Leaves	3.71	Blackberries	6.20	Eggplant	9.50	Horsebeans	14.30	Mustard Seed	19.25
Maple Sugar	0.20	Cream	3.90	Leek Leaves	6.25	Almonds	10.10	Poppy Seed	14.48	Romaine Lettuce	19.40
Oleomargarine	0.40	Pears	3.90	Figs	6.30	Walnuts	10.10	Celery	14.50	Swiss Chard	19.40
Olives	0.46	Grapes	4.00	Pecans	6.75	Lamb's Lettuce	10.20	Beans	14.86	Dog's Milk	19.75
Molasses	0.88	Plums	4.17	Cowpeas	6.85	Barley	10.27	Mare's Milk	15.05	Cheese, aver.	20.20
Dates	1.00	Chicory	4.30	White Bread	6.85	Peanuts	10.60	Egg's Yolk	15.22	Cucumbers	20.20
Pineapples	1.40	Raspberries	4.50	Onions	7.25	Sorghum	10.60	Cottage Cheese	15.35	Brussels Sprouts	20.25
Cranberries	1.60	Apples	4.52	Raisins	7.30	Tomatoes	10.75	Eggs	15.72	Dill	20.30
Tamarinds	1.67	Sugarbeets	4.60	Filberts	7.30	Peas, dry	11.20	Cow's Milk	15.79	Rabbit's Milk	22.80
Kohlrabi	1.70	Whole Wheat Bread	4.75	Salmon	7.30	Champignons	11.50	Asparagus	16.07	Rice Bran	22.85
White of Egg	1.85	Chocolate	4.80	Artichokes	7.40	Oysters	11.50	Buffalo Milk	16.15	Pike	23.00
Polished Rice	2.15	Cocoanut	4.80	Potatoes	7.47	Red Radishes	12.00	Swine's Milk	16.20	Pumpkins	23.80
Red Currants	2.17	Horseradish	4.96	Jerusalem Artichoke	7.65	Whey	12.00	Caraway seed	16.25	Radishes	23.80
Black Currants	2.27	Water Chestnut	5.10	Whole Rye	7.80	Currants, dry	12.40	Lettuce	16.62	Rye Bran	26.70
Cherimoyas	2.43	Corn	5.25	Human Milk	7.84	Beechnuts	12.81	Leek's Bulb	16.70	Truffles	27.65
Guavas	2.44	Lemon	5.25	Pork	7.86	Salsify, black	12.95	Meat, average	17.00	Brain	27.30
Pomegranates	2.50	Chestnut	5.50	Chicken	8.00	Millet	13.00	Camel's Milk	17.20	Liver	27.30
Red Beets	2.55	Cherries	5.54	Huckleberries	8.05	Chickpeas	13.10	Soy Beans	17.50	Wheat Bran	27.80
Mango	2.60	Watermelon	5.60	Chives	8.12	Pine Nuts	13.15	Sheep's Milk	17.70	Kale	35.50
White Flour	2.80	Kidney Beans, in pod, green	5.65	Beets	8.27	Brazil Nuts	13.30	Spinach	18.05		
Bananas	2.85	Limes	5.70	Corn, green	8.28	Buckwheat	13.35	Rutabagas	18.10		
Red Cabbage	3.00	Rye Crisp	5.85	Rice, green	8.60	Skim Milk	13.40	Turnips	18.25		
Grape Fruit	3.32					Sea Fish	13.50	Rhubarb	18.41		

CHLORINE (Cl)

Contained in 1000 parts water-free substance

Rye	0.01	Peas	0.53	Bananas	2.70	Cow's Milk	8.04
Cocoabeans	0.01	Rolled Oats	0.60	Pike	2.90	Turnips	8.30
Rice	0.02	Beans	0.69	Cauliflower	3.10	Celeriac	8.45
Almonds	0.06	Corn	0.80	Leeks	3.10	Sorrel	8.70
Olives	0.06	Sunflower Seed	0.90	Tomatoes	3.10	Beets	9.00
Whole Wheat	0.07	Chickpeas	0.95	Carrots	3.18	Nettles	9.09
Chestnuts	0.07	Pineapples	1.00	Cocoanuts	3.20	Savoy Cabbage	10.03
Walnuts	0.12	Beechnuts	1.03	Champignons	3.45	Parsnips	10.40
Prunes	0.15	Oatmeal	1.10	Dandelions	3.47	Cabbage	10.45
Lemons	0.18	Truffles	1.10	Dates	3.90	Whey	11.20
Apricots	0.20	Watermelons	1.10	Kohlrabi	4.10	Spinach	12.03
Gooseberries	0.22	Corn, green	1.12	Chives	4.40	White of Egg	12.08
Peanuts	0.23	Strawberries	1.20	Asparagus	5.10	Lettuce	13.82
Oranges	0.29	Onions	1.35	Red Blood Corpuscles	5.68	Dill	14.75
Pumpkins	0.30	Guavas	1.55	Human Milk	6.38	Bile	15.06
Barley	0.35	Mangos	1.55	Sea Fish	6.50	Blood of Bullocks	15.14
Corn	0.35	Potato	1.55	Cucumbers	6.60	Cheese	26.20
Oats	0.35	Meat, average	1.56	Cottage Cheese	7.10	Blood Plasma	36.20
Grapes	0.35	Lentils	1.61	Swiss Chard	7.40	Blood Serum	40.00
Yolk of Egg	0.45	Artichokes	2.06	Salmon	7.60	Oysters	44.50
Cherries	0.48	Poppy Seed	2.12	Water Cress	7.75	Lymph	54.75
Mushrooms	0.51						

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